

THE NAVY'S ENERGY & ENVIRONMENTAL MAGAZINE

# Currents

fall 2016

Navy Intensifies

## Modernization of Red Hill

Bulk Fuel Storage Facility

Improvements in Oversight, Technology &  
Operating Procedures Guard Against Future Releases

PMRF Honeybee  
& 2016 Energy  
Action Month  
Posters Inside!

NAVFAC Far East Preserves Culturally, Ecologically Significant Firefly Species in Japan  
NUWC Newport Leads Navy's Research of Fuel Cell Technology  
NPS Investigates Renewable Powered Heating Ventilation &  
Cooling with Thermal Storage

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# THE NAVY'S ENERGY & ENVIRONMENTAL MAGAZINE **Currents**

**Chief of Naval Operations  
Energy and Environmental Readiness Division**

**DIRECTOR**

Rear Admiral Lou Cariello

**ACTING DEPUTY DIRECTOR**

Dr. Frank Stone

**DIRECTOR, COMMUNICATION AND OUTREACH**

Kenneth Hess

kenneth.hess@navy.mil

703-695-5077

**Currents Staff**

**MANAGING EDITOR**

Bruce McCaffrey

Bruce McCaffrey Consulting, Inc.

brucemccaffrey@sbcglobal.net

773-376-6200

**CONTRIBUTING WRITERS**

Kathy Kelley

Cordelia Shea

**ART DIRECTOR**

Victoria Bermel

**GRAPHIC ARTIST**

Amy Jungers

**DISTRIBUTION MANAGER**

Lorraine Wass

ljwass@outlook.com

207-384-5249



facebook.com/navycurrents



twitter.com/navycurrents



instagram.com/navycurrents



In an effort to enhance safety measures and minimize vulnerabilities, the U.S. Navy continues to significantly increase its investment in the one-of-a-kind Red Hill Bulk Fuel Storage Facility. These efforts will improve operation standards

and management oversight to ensure Oahu's drinking water remains safe.

*Eric Semans*

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### **Navy Intensifies Modernization of Red Hill Bulk Fuel Storage Facility**

Improvements in Oversight, Technology & Operating Procedures Guard Against Future Releases

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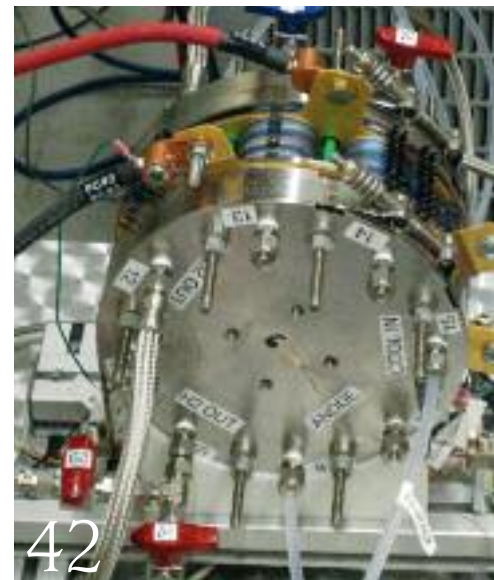
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## Improvements in Oversight, Technology & Operating Procedures Guard Against Future Releases

**I**n an effort to enhance safety measures and minimize vulnerabilities, the U.S. Navy continues to significantly increase its investment in the one-of-a-kind Red Hill Bulk Fuel Storage Facility. These efforts will improve operation standards and management oversight to ensure Oahu's drinking water remains safe.

The Red Hill Bulk Fuel Storage Facility at Joint Base Pearl Harbor Hickam is a key component of the Navy's operations in the Pacific and Asia, consisting of 20 tanks, each able to store more than 12.5 million gallons of jet or marine fuel. Red Hill is believed to be the largest underground fuel storage facility of its kind in the world. According to Rear Admiral John Fuller, Commander, Navy Region Hawaii and Naval Surface Group Middle Pacific, the tanks are a strategically critical enabler for forces mobilizing anywhere in the Pacific—from the West Coast and Hawaii to Asia and the Middle East.





Navy Intensifies

of **Modernization**  
**Red Hill**

**Bulk Fuel Storage Facility**

A work crew meticulously inspects the 84,000 square feet of quarter-inch steel plates that line the cement tanks at the Red Hill Fuel Bulk Storage Facility.

*Eric Semans*




An employee inspects a tank at the Red Hill Fuel Bulk Storage Facility.

In January 2014, the facility experienced its first and only extreme fuel release since formal reporting requirements were established in 1988. Since that time all releases must be reported to the State of Hawaii Department of Health (DOH). Due to the absence of regulatory reporting requirements prior to 1988, the Navy's records from the date the Red Hill facility was placed into service (1943) to 1988 do not provide detailed information regarding releases from the tanks. Through enhanced safety measures and oversight, combined with modernization projects already underway, the Navy has taken steps to dramatically minimize the probability of future incidents.

## Creating Red Hill

Because of the escalating tension in Europe and Asia early in the last century, the Navy grew concerned about the myriad above-ground fuel tanks at Pearl Harbor and their vulnerability to air attack. Construction began on the Red Hill facility in 1940.



The inside of a fuel tank.

For three straight years as many as 4,000 people (at peak construction) worked non-stop to complete the facility, except for a one-day halt during the Imperial Japanese Navy's attack on Pearl Harbor on December 7, 1941.

Workers began construction of Red Hill by excavating and removing surface soil on the top of the Red Hill

**In January 2014, the facility experienced its first and only extreme fuel release since formal reporting requirements were established in 1988.**

ridge to expose the underlying geology (i.e., basalt). Engineers and construction crews then created each tank by first excavating a 14-foot-wide vertical shaft that connected an upper and lower access tunnel, then boring a 100-foot-diameter tunnel in between.

Next came the tough part—building each tank from the outside in, first pouring the concrete shell, then installing the steel plates to fortify each structure. At the base of each tank is a large concrete foundation that provides additional support.



## More About the Construction of Red Hill

As World War II began to take shape, U.S. military officials became concerned about the vulnerability of the existing fuel storage facility at Pearl Harbor, which consisted of a series of above-ground tanks. Well before the Pearl Harbor attack, it was decided that a new underground facility was needed.

The site chosen would provide unprecedented flow rates due to its elevation. In addition, the site's unique geological characteristics, including basalt rock, could support such large tanks.

The original plan was for four large underground tanks—they would be horizontal, as all underground tanks were at the time. However, midway through the planning process, the project manager and a consultant had a better idea. They decided that building vertical tanks would be faster and easier, because a central shaft would allow construction debris to be excavated through a series of conveyor belts located in the lower access tunnel, which enabled construction and excavation to occur simultaneously. Plans were changed to build two rows of ten vertical tanks.

In addition to the tanks, upper and lower access tunnels would be built, as well as cross-tunnels to connect the center shafts. The tunnels and shafts were built prior to the tanks to allow excavation during tank construction.

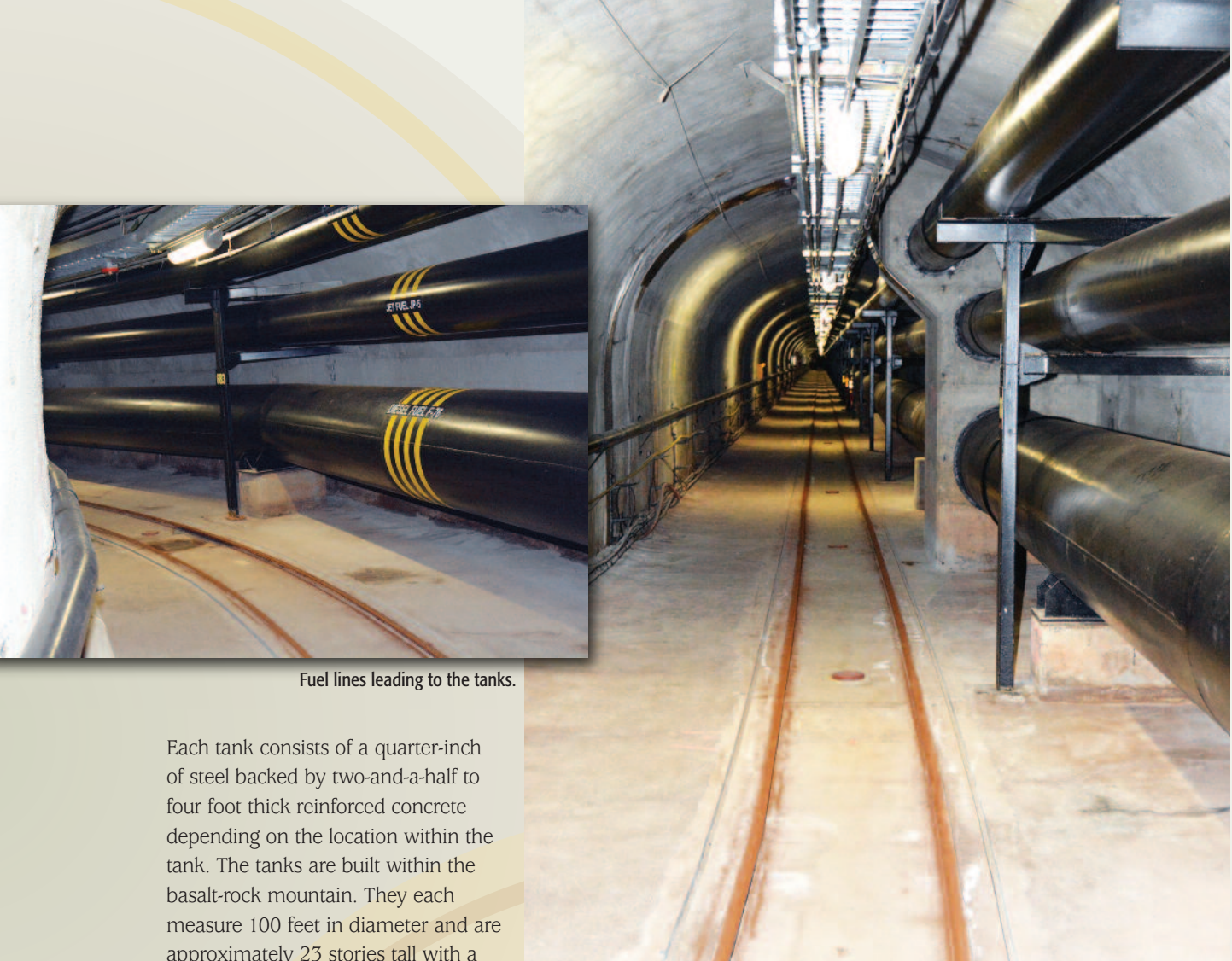
Additional access tunnels were also built around the site of each proposed tank. Miners worked in these tunnels to carve out the tank's dome. Building the dome first provided miners with

more protection against cave-ins. After the dome on each tank was finished, miners would descend into the central shaft and begin removing the rock between them and the outside edges of the dome. As the rock fell, it would fall into the shaft and onto conveyor belts below. Then, a rock crusher would crush the rock down to 10-inch diameter pieces for disposal. After enough rock was cleared, scaffolding was built around the entire inner circumference of the tank and a platform erected. Miners would lower themselves by rope, insert dynamite into the rock wall, return to the platform then detonate the explosives. They would do this again and again.

After the entire area was hollowed out, gunite (a mixture of cement, sand, and water applied through a pressure hose, producing a dense hard layer of concrete used in building for lining tunnels and structural repairs) was used to line the basalt rock. Workers then began to erect the steel liner and rebar incrementally so that they could pour concrete in stages. Concrete was poured continually and workers had to remove wooden shoring as concrete filled. Grout was injected to fill every void space between. When finished, the tanks were tested by slowly filling them with water.

### Red Hill by the Numbers

1. Each tank is large enough to hold a 20-story building.
2. The facility can hold nearly six million barrels of oil.
3. To create each dome, concrete was poured for 70 straight hours.
4. The tanks contain enough steel to build 12,000 classic cars, enough concrete to build five miles of interstate highway.



Fuel lines leading to the tanks.

Each tank consists of a quarter-inch of steel backed by two-and-a-half to four foot thick reinforced concrete depending on the location within the tank. The tanks are built within the basalt-rock mountain. They each measure 100 feet in diameter and are approximately 23 stories tall with a capacity to hold more than 12.5 million gallons of fuel. A gravity-fed distribution system delivers fuel from the tanks to Pearl Harbor, three-and-a-half miles away, and can operate manually even if cut off from electricity. In fact, the facility can operate completely “off the grid” requiring no connection to the Internet or outside power source.

The tanks at Red Hill are designated as field-constructed Underground Storage Tanks (UST), a category of tank that had until recently been exempt from certain U.S. Environmental Protection Agency’s (EPA) UST regulations. Even when the tanks were exempted from EPA requirements, the Navy conducted routine inspections to ensure they held the facility to the highest maintenance and operational standards, meeting or exceeding industry standards. In the early 2000’s, the Navy and the U.S. Department of

Defense’s Defense Logistics Agency (DLA) spent millions of dollars installing a state-of-the-art inventory management system that can measure each tank’s total inventory in real-time. Over the last six months, the Navy has been working collaboratively with EPA to establish rigorous inspection criteria for operations, maintenance and safety practices.

## The Groundwater Protection Plan

Many entities, including the Navy, University of Hawaii and U.S. Geological Survey (USGS), study the movement of groundwater in and around Red Hill. Of note, not all groundwater makes its way to drinking water sources. Navy modeling to date indicates any fuel constituents in the groundwater are not likely to reach any of Oahu’s drinking water sources.

**Each tank consists of a quarter-inch of steel backed by two-and-a-half to four foot thick reinforced concrete depending on the location within the tank.**

Between 2005 and 2014, the Navy implemented the following actions:

#### 2005

- Quarterly groundwater monitoring and sampling at the Red Hill Facility.

#### 2007

- Environmental investigation to collect additional data for groundwater and contaminant fate (how and where it disperses) and transport modeling in order to provide better understanding and forecasting of potential impacts.
- A more in-depth human health risk assessment to evaluate potential impacts to drinking water.
- A contingency plan to protect the drinking water well located closest to the Red Hill Facility.

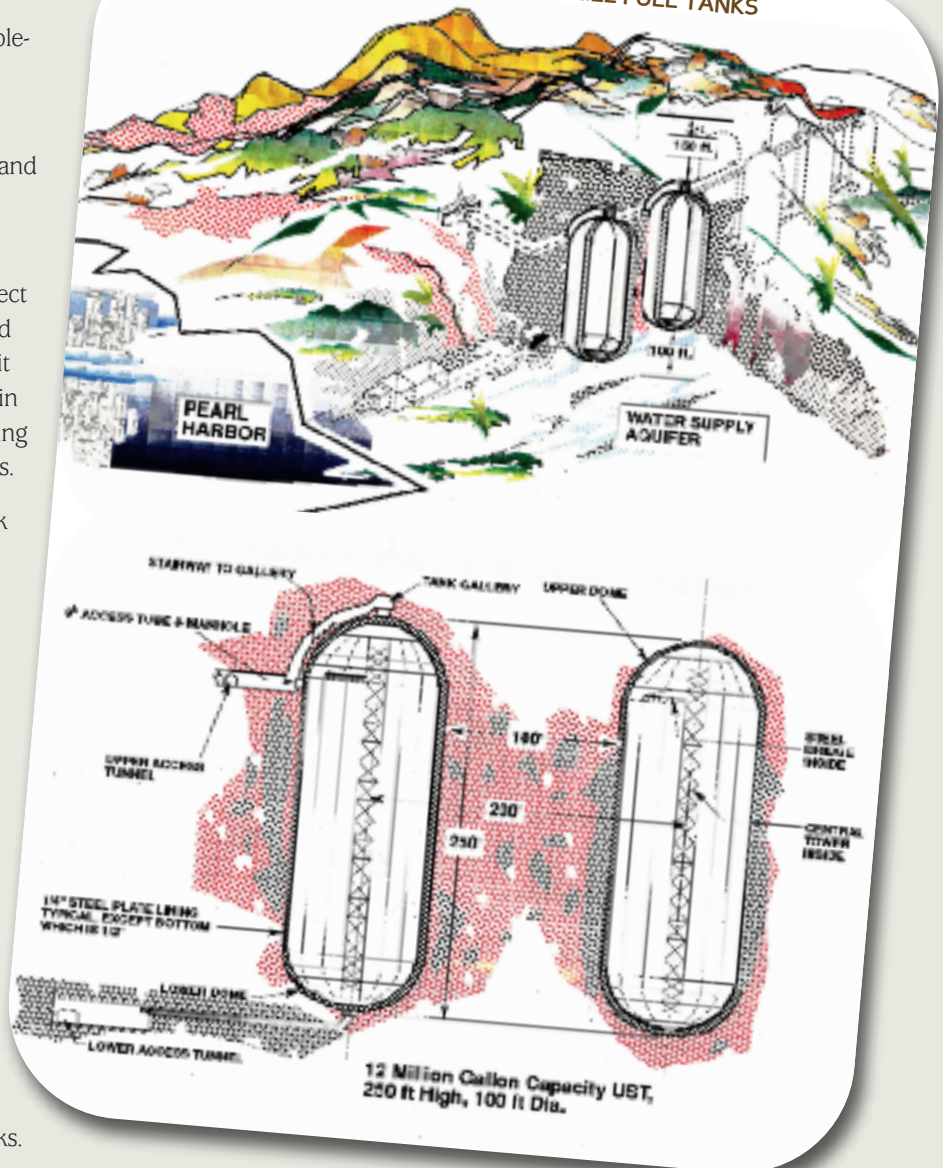
#### 2008

- The Groundwater Protection Plan (GWPP) (subsequently updated in 2009 and 2014) to mitigate risk associated with inadvertent fuel releases from the tanks.

The GWPP presents a step-wise strategy to help prevent risks associated with inadvertent fuel releases from the tanks, and focuses on long-term mitigations for those potential risks. These steps include:

- Implement a tank inspection and maintenance program.
- Describe a soil vapor monitoring program to support primary leak detection processes.
- Describe the groundwater sampling program and results of risk assessments.
- Implement a long-term groundwater monitoring program that will provide warning of potential risk to human health.
- Establish responsibilities and response actions that will be performed should groundwater data exceed Hawaii DOH environmental action levels.

### CUTAWAY VIEWS OF RED HILL FUEL TANKS



- Conduct periodic market surveys to evaluate best available leak detection technologies for large, field-constructed fuel storage facilities.

### Tank 5 Release

In December 2013, contractors finished up a three-year, scheduled routine maintenance upgrade on tank 5 at Red Hill. This work included cleaning, inspecting, and repairing any anomalies found in the tank. At the conclusion of the overhaul in January 2014, the Navy initiated a Return to Service (RTS) evolution, refilling the tank with Air Force jet fuel (JP-8). During the RTS, the inventory management alarms sounded. Red Hill operators first assumed the alarm system was malfunctioning because the tank was



The fuel pumps in the underground pump house.



recently overhauled and should not have been leaking. Eventually, the Navy determined the alarms were not false and reported a 27,000-gallon jet fuel loss to Hawaii DOH and the EPA.

## Testing the Water

The Navy's first concern was that fuel might enter the drinking water supply. The nearest drinking water shaft (operated by the Navy) is 3,000 feet away in a different direction, and provides water to 20 percent of the military families on Joint Base Pearl Harbor-Hickam. The next closest water shaft, which is located approximately one mile away, provides drinking water to the city of Honolulu. While all tests results for contamination have come back well within safe drinking water standards, the Navy, EPA, and Hawaii DOH are conducting a study to evaluate groundwater conditions and any potential impacts to groundwater resources in the area. The study will also assess how the presence or absence of natural, geologic barriers may inhibit groundwater and contaminant flow from Red Hill to nearby drinking water sources.

Following the tank 5 release in 2014, the Navy increased the testing frequency for drinking water and groundwater wells. The Navy now sends drinking water samples every quarter to certified independent laboratories that use EPA methods to analyze for contamination.

In May 2016, Admiral Fuller explained to *Hawaii Business* magazine: "There have been detects of trace amounts of fuel constituents near the Navy drinking water shaft." This is in the groundwater, not the drinking water. "We're talking 17 parts per billion, as opposed to zero. The misperception is that there's a spike, but the numbers were small enough that the testing facility had to estimate the amount because the numbers were so low. The 17 parts per billion is below the threshold of something we should be concerned about, which is 100 parts per billion."

"The tanks are not leaking, the water is safe and we're doing everything we can to make sure that continues," summed up Admiral Fuller.

## What Went Wrong?

How did a routine scheduled maintenance event go awry? Captain Dean Tufts, former commanding officer of the Navy Facilities Engineering Command Hawaii and lead engineer for Navy Region Hawaii responsible for maintaining Red Hill also spoke to *Hawaii Business* magazine. He described the maintenance process: "We visually inspect all the walls on this huge tank. We x-ray all the walls and look for any anomalies in the steel's thickness. The steel is a quarter-inch thick, backed by

**The tanks are not leaking, the water is safe and we're doing everything we can to make sure that continues.**

**—Rear Admiral John Fuller**

2.5 feet to 4 feet of concrete, backed by the basalt rock. If there are any kinds of nicks in the steel, what we're finding is that it's not corrosion. There's no air down there," he explains. The Navy empties and services tanks in this manner every 20 years. For the upgrade of tank 5—the sixth tank to be upgraded, the Navy used a new contractor.

"This contractor goes in, spends three years, does all the welding, does all the cleaning, does all the inspections, and an American Petroleum Institute certified engineer from the contractor signs off on it. It's like driving a new car out of the showroom. Then, we started getting alarms as we filled the tank. It's like when your check-engine light goes on. You think, 'That can't be right; it's brand new; it was just modernized.' And this was our mistake—we just reset the alarm. That happened a couple of times. So, by the time we realized, 'Oh, my gosh, this is really happening,' we had to move all the fuel into another empty tank. And by the time we moved the 12 million plus gallons into another tank, we had lost 27,000 gallons."

Subsequent analyses indicate that the leak was the result of faulty work by the Navy's contractor, compounded by a lack of quality assurance oversight by the Navy, as well as operator error. A subsequent tank 5 inspection revealed pinholes around improper welding repairs. In response to these findings, the Navy improved the oversight process for tank maintenance activities.

The Department of Defense has spent more than \$200 million on continual technological modernization and environmental testing at Red Hill since 2006. The facility employs state-of-the-art inventory management and automated control and communication systems to monitor fuel levels in each tank to one sixteenth of an inch and to control the movement of fuel throughout the facility. If a tank level decreases by as little as half an inch, alarms will sound in Red Hill's control room, which is staffed 24/7.

Additionally, the Navy implemented new standard operating procedures to increase contractor scrutiny and provide additional government oversight. These actions further decrease the likelihood of another maintenance failure in the future.

## The Administrative Order on Consent

An Administrative Order on Consent (AOC) is a binding legal agreement administered by EPA which mandates the corrective actions to be taken in the wake of an environmental violation. Representatives from the EPA, Hawaii DOH, Navy and DLA signed the AOC for Red Hill in September 2015. It acknowledges the shared responsibility to protect Oahu's drinking water supply and maintain Red Hill as a strategically vital resource.

## The AOC Players

The following parties signed the AOC:

### 1. EPA Region 9

EPA is the U.S. government agency that writes environmental regulations authorized by Congress. EPA has 10 regional offices, each of which is responsible for several states and territories. These offices carry out more specific tasks, including the particulars of UST cleanups. The offices of EPA Region 9 (Pacific Southwest) are located in San Francisco.

### 2. The Hawaii Department of Health

The mission of the Hawaii DOH is to protect and improve the health and environment for all Hawaii residents. The regional EPA office has given authority to the DOH to regulate USTs. The Hawaii State DOH offices are located in Honolulu.

### 3. Commander, Navy Region Hawaii

CNRH is the command responsible for providing, maintaining, and improving shore infrastructure, service, support, and training to enable Fleet operations. CNRH oversees all Navy supporting commands involved in the operation and maintenance of Red Hill. CNRH headquarters is located at Joint Base Pearl Harbor-Hickam.

### 4. Defense Logistics Agency

DLA is a combat logistics support agency of the United States Department of Defense (DoD) providing the military services with the full spectrum of logistics, acquisition, and technical services. As the DoD executive agent for bulk petroleum, DLA executes the integrated materiel management responsibility for bulk petroleum owned by the DoD. DLA's Pacific headquarters are located at Joint Base Pearl Harbor-Hickam.



An employee monitors the control systems.  
MC1 Nardel Gervacio



Lt. Cmdr. Andrew Lovgren, Fuels Director, Naval Supply Systems Command Fleet Logistics Center Pearl Harbor, explains the monitoring systems.  
MC1 Nardel Gervacio

The document includes a Statement of Work (SOW) prescribing actions the Navy must take, along with deadlines for completing each task. The SOW has eight areas:

1. Providing overall project management guidance.
2. Improving tank inspection, repair and maintenance.
3. Reviewing potential upgrades to the tanks.
4. Improving the facility's ability to detect leaks and test tank tightness.
5. Addressing current and future corrosion and metal-fatigue practices.
6. Investigating and remediating past releases.
7. Developing better approaches to protect and evaluate groundwater.
8. Thoroughly assessing the risks and vulnerabilities of the Red Hill facility.

Shortly after signing the AOC, Navy and DLA stakeholders met with representatives from EPA, Hawaii DOH and DLA, along with invited subject matter experts. During this meeting, attendees paid particular attention to groundwater monitoring. At that time, there were ten sampling locations. The team determined that four additional ground water monitoring wells were necessary to develop a more precise and useful modeling tool to study ground-

water movement. This model will help the Navy better understand how groundwater and fuel would move together if there was a release and improve the ability to assess and predict the potential migration of subsurface fuel constituents.

The Navy also issued reports in April 2016 outlining the state of current release detection measures and tank tightness testing, as well as ongoing efforts with corrosion and metal fatigue testing.

Hawaii DOH hosted a second meeting to address the SOW in May 2016. Participants included DLA, DOH and EPA as well as subject matter experts from the University of Hawaii, the Honolulu Board of Water Supply (BWS) and their consultants, State Department of Land and Natural Resources, and USGS. All participants went on record to say that all aspects of the Red Hill facility—to include infrastructure, security measures and operations practices—currently meet or exceed industry standards.

The newest groundwater monitoring well was installed in early August 2016. Admiral Fuller noted, "Public records confirm that all drinking water remains safe," adding, "this well is more tangible evidence that we are committed to keeping the drinking water safe."

**Due to the complex geology surrounding Red Hill,  
there is no easy answer regarding what  
happened to this fuel.**



Drilling equipment arrives at the first of four new groundwater monitoring well locations for the Red Hill Bulk Fuel Storage Facility.

*Denise Emsley*

## Moving Forward

The Navy is also evaluating a number of potential remediation methods for the fuel accidentally released in January 2014. The AOC mandates that these methods be evaluated based on the feasibility of implementation, suitability for use in complex geology, and effectiveness in reducing contamination. Due to the complex geology surrounding Red Hill, there is no easy answer regarding what happened to this fuel, and how quickly natural biological processes may break down the fuel over time.



Drilling equipment arrives at the first of four new groundwater monitoring well locations.

*Denise Emsley*



Drilling equipment specialists operate a drilling rig.

*Denise Emsley*



During the rock coring phase, core samples are carefully removed from the borehole and quickly handed off to geologists at 5-foot intervals. Geologists then observe and catalog the cores in order to develop a better understanding of the subsurface geology of the borehole.

*Denise Emsley*



Captain Ken Epps, left, commander of Naval Supply Systems Command Fleet Logistics Center Pearl Harbor, briefs members of the Honolulu BWS, Moanalua Valley Community Association, and Pearl City Neighborhood Board No. 21 during a visit to one of the fuel tanks at the Red Hill Facility.

Mazie Hirono, United States Senator from Hawaii, and Rear Admiral John Fuller, Commander of Navy Region Hawaii and Naval Surface Group Middle Pacific, tour the facility. Chief Mass Communication Specialist John M. Hageman



Today, the Navy and DLA continue Red Hill Facility inspections and modernization upgrades, to include the recently upgraded facility fire suppression, ventilation, and oil-tight door systems. Tank 5 repairs are ongoing and management plans to put the tank back into service only after the Navy, through careful and independent assessments, deems it suitable for operations.

The Navy prepared documents that EPA recently posted to their website at [www.epa.gov/red-hill](http://www.epa.gov/red-hill). This website contains a summary of meeting discussions, outlines, and reports the Navy and DLA prepared for the EPA and Hawaii DOH.

The Navy uses independent DOH-certified laboratories and EPA methods to test the water near Red Hill. Test results continue to verify that the drinking water near Red Hill is safe and remains within Federal and State standards. Water quality reports for Navy drinking water are available at <http://go.usa.gov/3E9MR>.

The Navy is committed to building trust with community leaders, elected officials and its neighbors by keeping regulators, stakeholders and the community informed. Over the last year, the Navy provided site tours to more than 500 community leaders and civic stakeholders so they could get a first-hand look at the

Red Hill facility and its operation. This past summer, Navy Region Hawaii provided briefings and tours for dozens of state senators and representatives and their staff members. The U.S. congressional delegation from Hawaii, many other members of Congress and dozens of local community leaders have toured Red Hill, and in the fall, the facility welcomed Dr. Janine Davidson, Under Secretary of the Navy, and Mr. Dennis McGinn, Assistant Secretary of the Navy for Energy, Installations & Environment.

“The Navy is on the leading edge of embracing new sources of energy and moving away from fossil fuels,” states Admiral Fuller. “At some point in the distant future we will no longer need Red Hill, but for now we must continue to rely on conventional power to protect our national security.” ⚓

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Kathy Isobe  
Navy Region Hawaii  
808-473-0662  
DSN: 315-473-0662  
[kathy.isobe@navy.mil](mailto:kathy.isobe@navy.mil)

**Test results continue to verify that the drinking water near Red Hill is safe and remains within Federal and State standards.**

# ONE OF MY Best Shots



I took this photo at the Pacific Missile Range Facility (PMRF) after helping a newly hatched green sea turtle make its way into the surf in the summer of 2015. PMRF's wildlife team monitored sea turtle nesting activity on the base throughout the 2015 sea turtle nesting season. Six green sea turtle nests were documented and protected from human disturbance. All six nests hatched successfully producing a total of 468 new baby turtles (a record high for one season at PMRF). Nearly all of the hatchlings made their way from nest to the ocean in the dark of night without incident.

In a few cases, biologists discovered baby turtles such as the one in this photo that had become trapped under the sand and were unable to exit on their own. In these cases, the young turtles were freed and placed near the ocean. The turtle in the photo crawled into the surf and disappeared under the waves a few minutes after this photo was taken. I used a Fujifilm XP waterproof digital camera, at a focal length of 16.3 mm and ISO 100 at f/8.

Ingrid Rotto ● Wildlife Technician ● Pacific Missile Range Facility ● [ingrid.rotto@gmail.com](mailto:ingrid.rotto@gmail.com)  
Questions about PMRF's wildlife program can be directed to Tom Savre at [thomas.savre.ctr@navy.mil](mailto:thomas.savre.ctr@navy.mil).

# Pulling Plants for Plovers

## Local Students Experience Conservation in Action at Naval Base Coronado

**NAVAL BASE CORONADO'S** partnership with the San Diego Zoo is providing local youth with a chance to experience on-the-ground conservation.

February is a busy time for the federally-protected Western Snowy Plover (*Charadrius nivosus nivosus*). These small shorebirds spend a great deal of time feeding and fattening up to prepare for the demands of migration and nesting season. At this time of year, many plovers may already be on their nesting grounds conducting early courtship rituals such as building practice nests in the sand, also known as "scrapes." When the timing is just

right, the female plover will select the best scrape and lay within it exactly three eggs.

At Naval Air Station North Island (NASNI), local high school students from the San Diego Zoo's Safari Park Conservation Corps were also busy preparing for the nesting season. The Conservation Corps is a program in which selected teens spend one day per month involved in a local hands-on conservation project.

On February 6, 2016, students, adult chaperones, and Naval Base Coronado (NBC) Environmental Department staff spent a sunny San Diego Saturday pulling an invasive weed from the dunes. The highway iceplant (*Carpobrotus edulis*) is a low-growing succulent, originally brought to California as a way to protect the landscape against erosion, but which now invades sensitive dune ecosystems by covering the sand in a thick matte of vegetation. This leaves little room for the plover to place her eggs.



The red sand verbena (*Abronia maritima*), a rare native dune plant, grows on NASNI and will be able to expand further with the removal of non-native iceplant.

Tiffany Shepherd

### More About Naval Base Coronado & Naval Air Station North Island

**NBC IS A** consortium of eight Navy installations, including NASNI, which accommodates the training requirements of 16 helicopter squadrons, two fixed wing squadrons, two aircraft carriers, four SEAL teams, Navy Expeditionary Combat Command squadrons, and other air, surface and subsurface commands.

In addition to the Western Snowy Plover, NASNI is home to the endangered California Least Tern and the Burrowing Owl, which is protected under the Migratory Bird Treaty Act. Training activities are prohibited in areas where/when these species are present.

NBC and their partners at the zoo are finding creative ways to make more room for the plovers while giving local youth a chance to help. Since December 2014, NBC Natural Resources and Zoo staffs have worked together to organize weekend events on the base where students can experience on-the-ground conservation efforts. In addition to invasive plant removals, the events have included a beach clean-up and installation of protective fencing.

The weekend event is just one of the ways NBC and the San Diego Zoo are working together for wildlife conservation. The Zoo has been involved in NBC's long-standing endangered species program, which also includes management of the endangered California Least Tern (*Sternula antillarum brownii*), for over 18 years. In the last five years, the Navy and Zoo began developing a more focused nest monitoring program for the Least Tern and Snowy Plover, working via cooperative agreement under the California Cooperative Ecosystems Studies Unit (CESU) program. Current and future efforts are focused on answering long-standing research questions, such as:

- What migratory and stopover routes do California Least Terns use during the non-nesting season?
- What techniques can be developed to improve Least Tern fledgling productivity estimates?
- What are the meta-population dynamics of the Snowy Plover within Southern California?

The partnership is paying off for the plovers. During the most recent 2015 nesting season, biologists documented



A Snowy Plover nest found on NBC.  
Tiffany Shepherd

## About San Diego Zoo's Conservation Efforts

**SAN DIEGO ZOO Global** is a conservation organization dedicated to the science of saving endangered species worldwide. San Diego Zoo Global operates three facilities: the San Diego Zoo, the San Diego Zoo Safari Park, and the San Diego Zoo Institute for Conservation Research.

The institute is the largest zoo-based multidisciplinary research effort in the world. More than 150 scientists carry out research vital to the conservation of animals, plants, and habitats in over 80 countries worldwide. The institute focuses on bringing people and groups together to collaborate on solutions.

One long-term partnership that's proving successful is the institute's partnership with the Navy on San Clemente Island. A captive breeding program is working to restore the population of the San Clemente Loggerhead Shrike (*Lanius ludovicianus mearnsi*), a small songbird that was once named "North America's rarest bird." Found only on San Clemente Island, the program has seen the bird population grow from 14 individuals to 67 breeding pairs in 2013. (For more about this project, see our article "Navy Region Southwest Leverages Key Partnerships" in the fall 2013 issue of *Currents* at [http://greenfleet.dodlive.mil/files/2013/11/Fall13\\_Region\\_Southwest\\_Partnerships.pdf](http://greenfleet.dodlive.mil/files/2013/11/Fall13_Region_Southwest_Partnerships.pdf).)





Snowy Plover (*Charadrius nivosus*).  
U.S. Fish and Wildlife Service Southeast Region



Volunteers pose for a photo while removing  
non-native iceplant from Snowy Plover habitat.  
Katrina Murbeck



Snowy Plover running chick.  
Hans Hillewaert

Snowy Plover nest at  
Silver Strand Training Complex,  
San Diego County, CA.



Hardworking volunteers pull iceplant  
from the sand dunes.  
Tiffany Shepherd

## The Basics About the Western Snowy Plover

ACCORDING TO THE U.S. Fish and Wildlife Service (USFWS), the Western Snowy Plover is a small shorebird, about six inches long, with a thin dark bill, pale brown to gray upper parts, a white or buff colored belly, and darker patches on its shoulders and head.

The Pacific coast population of the western snowy plover was listed as threatened on March 5, 1993. This population is defined as those individuals that nest adjacent to tidal waters of the Pacific Ocean, including all nesting birds on the mainland coast, peninsulas, offshore islands, adjacent bays, estuaries, and coastal rivers. The main reason for their endangered status, according to USFWS, is human activity encroaching on breeding and nesting sites.

The current known breeding range of this population extends from Washington State to Baja California, Mexico. The breeding season in the United States extends from March 1 through September 30, although courtship activities have been observed during February.

A male Snowy Plover stands on NBC among native beach evening primrose (*Cammissonia cheirantifolia*).

Emily Rice



Volunteers from the San Diego Zoo's Safari Park Conservation Corps and NBC stand on a pile of non-native iceplant that they removed from Snowy Plover habitat.

Katrina Murbock

record-high productivity, finding that each plover pair produced an average of 2.5–2.7 fledglings, a statistic which exceeds the U.S. Fish and Wildlife Service Recovery Plan goal. In addition to Least Tern and Snowy Plover nest monitoring and research, NBC's comprehensive management program also includes annual site preparation, predator management, conservation law enforcement patrols, and monitoring of sensitive raptors.

As NBC looks ahead to planning future volunteer events to benefit the plovers, it is clear that bringing local youth out to lend a hand will lead to long-term conservation successes for both the plovers and the young people who care for them. ⚓

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Tiffany Shepherd  
Naval Base Coronado  
619-545-3703  
DSN: 735-3703  
tiffany.shepherd@navy.mil

# NAVFAC Far East Preserves Culturally, Ecologically Significant Firefly Species in Japan

## Efforts Concentrate on Managing & Protecting Critical Habitat

**PERSONNEL FROM THE** Naval Facilities Engineering Command (NAVFAC) Far East are helping to preserve a culturally and ecologically significant firefly species in Japan through effective captive breeding and habitat protection programs.

Common in traditional literature and a symbol of the Japanese summer, fireflies have special cultural significance in the land of the rising sun. Early in the evening, Genji and Heike fireflies delight people gathered to watch them illuminate and fly along local streams. The ephemeral display—firefly season only lasts between late May and early August—seems to end too quickly. The firefly is used as a metaphor in popular Japanese songs which mark the end of a ceremony, event or even the end of the year.

Fireflies hold ecological significance as well, with many worrying about their diminishing numbers. Increasing

urbanization, water pollution and artificial lights have contributed to a decrease in firefly populations. As a result, Japan's Kanagawa prefectural government has designated the Heike firefly to a status of 'near threatened.'

"The firefly is the most familiar insect for the people in Japan since ancient times. This is especially true in the summer when the people watch the charming Genji firefly," said Dr. Nobuyoshi Ohba, a leading firefly expert in Japan. "These species have been involved in the lives of people for a long period of time along Japan's rural landscape and rice field. However, the fireflies have decreased as people's lifestyle gradually changed due to urbanization. So there are very few now."

The Ikego Housing Area is one of seven U.S. Navy facilities which comprise Commander, Fleet Activities (FLEACT) Yokosuka in Kanagawa prefecture. Ikego's 710 acres are

steadily being surrounded by the growing cities of Zushi, Yokosuka and Yokohama. As is typical of military reservations, U.S. military-managed installations become natural area islands, a refuge for flora and fauna surrounded by urbanization. Within Ikego are 510 acres of undeveloped forest area, having a diverse ecology and high quality streams. Ikego is considered an environmentally significant area providing preferable habitats for the Genji and Heike fireflies.

Six species of fireflies are observed in Ikego. These include Japan's most wide spread firefly, the Genji (*Luciola cruciate*) and the more geographically limited Heike (*Luciola laterali*). Of special interest is that both firefly species have an aquatic larval stage. There are about 2,000 firefly species worldwide, and only 10 aquatic larval stage species are known. The rest are species having a terrestrial only lifecycle. The Genji fireflies are also biological indicators of a healthy fresh water aquatic ecosystem.

The firefly is the most familiar insect for the people in Japan since ancient times.

—Dr. Nobuyoshi Ohba

For 10 years, NAVFAC Far East environmental employees at FLEACT Yokosuka have been exclusively managing and protecting the existing firefly habitat. Recently, a portion of land in Ikego Housing Area was designated as joint use between the city of Zushi and the U.S. Navy. The City of Zushi and U.S. Navy created a Memorandum of Understanding (MOU) to collaborate on the protection of endangered species, land use strategies for wildlife corridors, removal of non-native animals and protection of firefly habitat.

“It is important to share this opportunity with Zushi City and the U.S. Navy to preserve the firefly species and its habitat in Ikego,” said Ohba.

Efforts by Zushi City to enhance biodiversity and ecosystem health are done by performing on-site maintenance work removing unwanted vegetation to keep streams clean and promote habitat for the aquatic Kawanina snail species (*Semisulcospira libertina*) which are

the final instar larva stage (the shedding and molting of exoskeleton to convert into adult flying insect).

In February 2016, NAVFAC Far East employees and Zushi City officials released 67 Genji firefly larvae in a stream located in the joint use area. The event was an example of collaborative efforts to continue sound environmental practices in the joint use area outlined in the MOU.

For 10 years, NAVFAC Far East environmental employees at FLEACT Yokosuka have been exclusively managing and protecting the existing firefly habitat.

preyed upon by the firefly larvae. Another enhancement is maintaining trees to provide shade, keeping stream water temperatures from becoming too warm.

NAVFAC Far East conducts captive breeding of Genji and Heike fireflies. Adult fireflies are collected, bred in laboratory aquariums, and larvae released into streams. In 2015, the natural resources program successfully enhanced the species, evident in the hatching of 707 Genji and 95 Heike fireflies, resulting in 198 Genji and 47 Heike surviving to

“The City of Zushi and the local community have raised awareness for the protection of the fireflies’ environment,” said Public Works Department (PWD) Yokosuka Natural Resources Program Manager Hisako Mawatari. “I hope we can plan more nature programs like this in the future.”

NAVFAC Far East has partnership agreements that enable hosting firefly viewing events at Ikego, open to all members of the local Japanese community and military families.



Adult Genji fireflies  
at Ikego Housing Area,  
Kanagawa, Japan.  
James Johnson

Adult Genji firefly.  
uniprot.org



Genji firefly larvae ready for release into Ikego Housing Area stream.

*James Johnson*

On June 9, 2016 more than 100 people saw Genji fireflies' synchronized flashing along the stream. "This event proves to be an effective educational and awareness tool," said PWD Yokosuka Environmental Director Chuck Sayon. "It reinforces the U.S. Navy's commitment to protection efforts for endangered species and receives high local community praise including recognition from the Zushi City Environment and Urban Greenery Planning Division."



Natural Resources Program Manager Hisako Mawatari (left) and a Zushi City official release Genji firefly larvae into an Ikego Housing Area stream.

*James Johnson*

"Our natural resources management program is meeting the challenge of protecting natural resources by partnering with local and prefectural governments to meet U.S. and Japanese government environmental protection standards. We encourage participation from military and civilian personnel, schools, base residents, and local Japanese nationals. These efforts improve host nation relations and provide a sense of pride and ownership," said Sayon.

In 2015, FLEACT Yokosuka received the Chief of Naval Operations Environmental Award for Natural Resources Conservation, Small Installation for its efforts to promote the conservation of natural resources, including the increase of the firefly population and restoration of their habitat. [🔗](#)

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James Johnson  
Naval Facilities Engineering Command  
Far East  
046-816-5049  
DSN: 315-243-5049  
[james.johnson1@fe.navy.mil](mailto:james.johnson1@fe.navy.mil)



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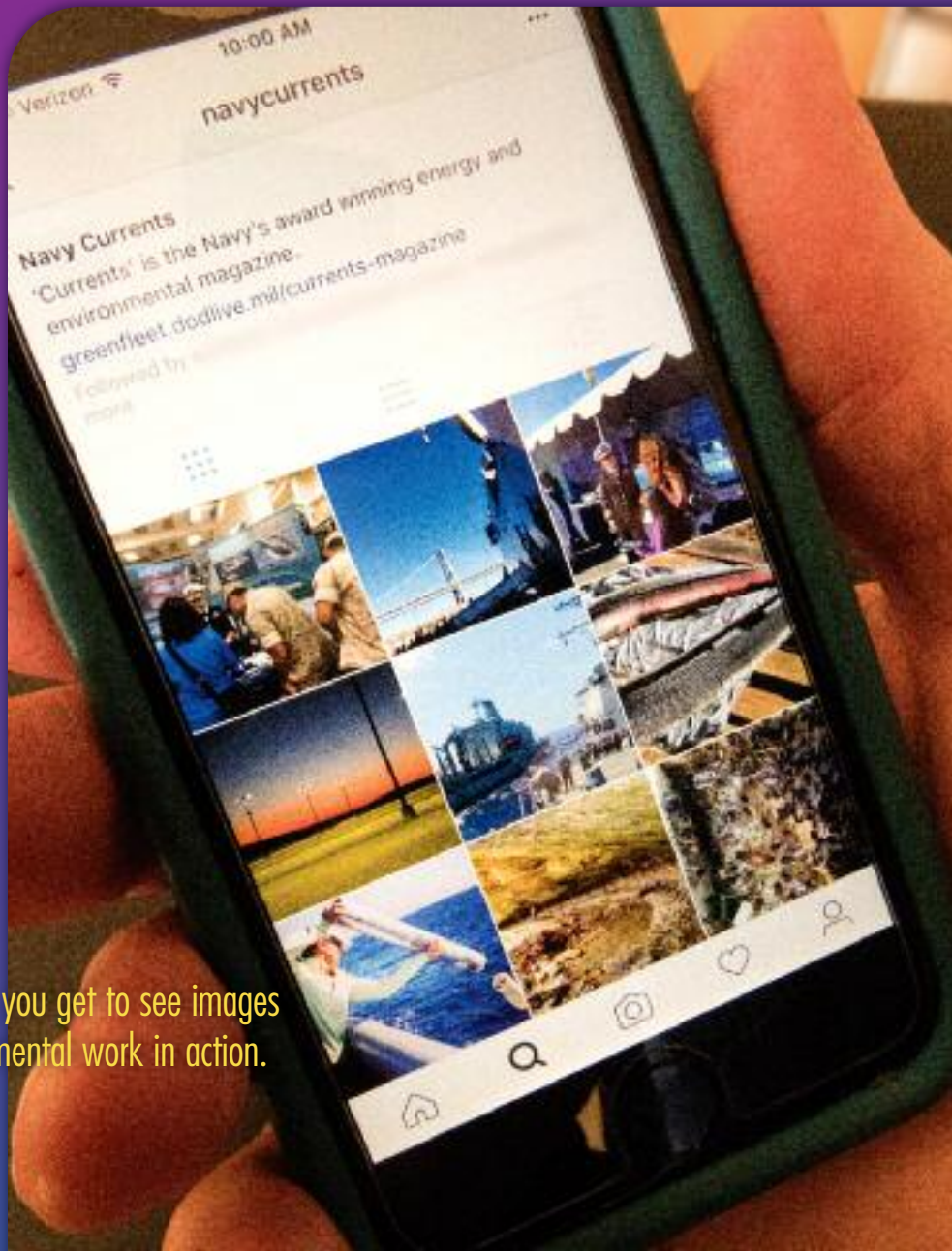
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# Kauai's First Documented Green Sea Turtle Nest of 2016 Hatches

## Sixty-three Hatchlings Emerge from Pacific Missile Range Facility

**PACIFIC MISSILE RANGE** Facility's (PMRF) lone 2016 green sea turtle nest, located a quarter-mile south of Shenanigan's All Hands Club, hatched on the evening of July 19, 2016.

PMRF Security found the nest on May 25 during one of their regular beach surveys and reported the incident to PMRF Wildlife

Technician Rachel Herring. Herring then worked with Jason Shimauchi from the U.S. Department of Agriculture Wildlife Services to fence the nest to protect it from pedestrian and vehicle traffic. The nest hatched at 57 days, just shy of the 60-day average seen in Hawaii.

Tracks were discovered leading from the nest to the ocean on July 20, and at least two more distinct fresh sets of tracks were identified on the morning of July 21, indicating late hatchlings. PMRF Wildlife Technician Rebecca Johnson worked

with state biologist Don Heacock to excavate the nest on July 23. Biologists do this for two reasons—turtle hatchlings can remain trapped underground, unable to dig to the surface; and biologists can collect information on the nest by counting egg shells, thereby determining the number of hatchlings released from

the nest, or collecting unhatched eggs to perform DNA analysis and link the nest to a certain female in the population.

Upon excavation, Heacock and Johnson found no hatchlings, 63 egg shells, and only one unhatched egg beneath the sand. With a total clutch



Green sea turtle hatchlings act on pure instinct to dig their way out of the nest and swim out to sea where they will spend the next 25–35 years before returning to shore to nest themselves.

*John Nelson*

size of 64 and 98 percent hatching success, this was a small but extremely successful nest. Heacock stated that this nest was likely laid by a young, smaller green sea turtle (*Chelonia mydas*) judging by egg color and size, as well as clutch size.

According to the National Oceanic and Atmospheric Administration's website, green sea turtles are thought to live 60–70 years, reaching sexual maturity at 25–35 years. Females will generally reproduce every two to three years at that point, and lay three to six clutches in a season. On average, one hundred eggs are deposited in each nest.

The Hawaiian green sea turtle is a threatened distinct population segment protected under the Endangered Species Act, the majority of the population (approximately 90 percent) nesting in the Northwest Hawaiian Islands on the beaches of French Frigate Shoals. Most threatening to Hawaii's population, besides limited nesting area, is the disease Fibropapillomatosis, which produces tumors on soft body parts of the turtles. While these tumors are not themselves harmful, they can obstruct movement or hinder turtles' ability to see and feed.

Turtles are frequently seen basking at PMRF at "Turtle Cove," the outpouring of Nohili Ditch on the north side of the base, and can occasionally be seen at other areas on base as well. PMRF is an attractive location for nesting turtles with its expansive miles of relatively intact, sandy beach. As noted by Heacock, PMRF is also ideal in terms of its relatively low vehicle traffic and lack of nighttime activity on the beach. In 2015, seven nests produced a total of 468 sea turtle hatchlings.

The naval base works closely with federal and state agencies, schools, conservation organizations, the public, and the host community to implement groundbreaking

initiatives towards conservation, environmental protection, and the protection of threatened and endangered species.

PMRF is the recipient of the 2015 Chief of Naval Operations Environmental Award as well as the 2015 Secretary of the Navy Environmental Award for its achievements in environmental stewardship. [!\[\]\(30dfa619cea8b8790c5e9066d4f2637a\_img.jpg\)](#)

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Robert Purdy  
Pacific Missile Range Facility  
808-335-4740  
DSN: 315-421-4740  
[robert.purdy1@navy.mil](mailto:robert.purdy1@navy.mil)



State Biologist Don Heacock excavates nest, collecting data on the nest as well as looking for trapped hatchlings.  
*Rebecca Johnson*



Biologists collected 63 egg shells and one unhatched amniote from the nest cavity—these and the tracks are all that remain.  
*Rebecca Johnson*

# New Methodology Quantifies Non-Point Sources of Metal Pollutants in Stormwater

## NAVFAC EXWC Approach Includes Site Characterization & Importing Data into Management Tool

**THE NAVAL FACILITIES** Engineering Command (NAVFAC), Engineering and Expeditionary Warfare Center (EXWC) has developed a Geographic Information System (GIS)-based methodology to identify and quantify non-point sources of metal pollutants in stormwater runoff.

The Department of the Navy is addressing a multitude of stormwater related issues regarding compliance with their National Pollutant Discharge Elimination System

requirements. (Benchmark concentrations are the level of a substance present in the water body, and acute toxicity levels are the concentrations at which the U.S. Environmental Protection Agency (EPA) has determined exposure to be harmful to aquatic life.) In most cases, copper and zinc are two metals that have been recognized through Toxicity Identification Evaluations as the primary cause of toxicity in Navy stormwater runoff.

pollution. The new GIS methodology developed by NAVFAC EXWC aids in the identification and quantification of non-point sources of metal pollutants.

At Naval Base San Diego (NBSD), copper concentrations in stormwater must not exceed 63.6 micrograms per liter ( $\mu\text{g/L}$ ) and zinc concentrations must not exceed 117 $\mu\text{g/L}$ . (Note: These are only benchmark concentrations and not limits. Copper and zinc benchmarks may

In many areas, stormwater runoff from industrial and non-industrial areas is mixed in common stormwater conveyances, making it difficult to pinpoint which entities may be responsible for elevated metals concentrations.

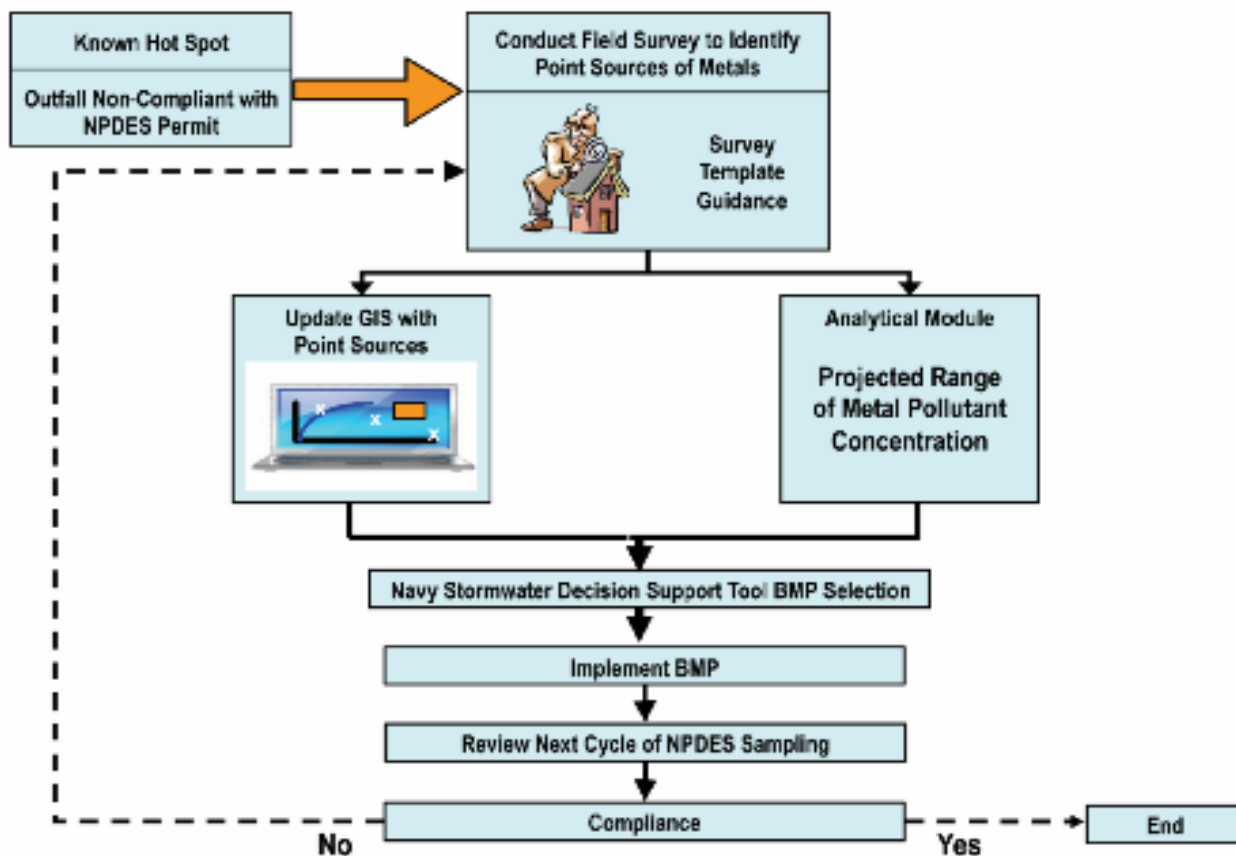
(NPDES) stormwater permits. Many Navy installations continue to struggle with NPDES permit requirements for stormwater due to low benchmark concentrations of metal pollutants in stormwater runoff from industrial areas and particularly stringent acute toxicity require-

In many areas, stormwater runoff from industrial and non-industrial areas is mixed in common stormwater conveyances, making it difficult to pinpoint which entities may be responsible for elevated metals concentrations. This is commonly known as non-point

be less stringent depending on the region in question.)

### The Demonstration

The objective of this demonstration project was to provide NBSD and other applicable Naval bases with a GIS-based methodology and Non-



Methodology flowchart for identifying and quantifying stormwater pollutants.

point Source Stormwater Management (NPSSM) tool to help identify and quantify significant non-point sources of metal pollutants (particularly copper and zinc) that contribute to benchmark exceedances at stormwater outfalls.

A GIS approach was used for the following reasons:

- NAVFAC has an existing GIS infrastructure.
- GIS provides good visual display of results.
- The future of data management associated with maps is a GIS platform.
- The model is non-proprietary and requires very little maintenance.



Areas of potential concern for outfalls outside of Navy jurisdiction.

- GIS data may be uploaded onto the Navy's GIS server where Navy installations around the world may access the data.

During the demonstration, participants conducted site characterizations to identify potential metal pollutant point sources, particularly for copper and zinc. Using GIS and handheld Global Positioning System (GPS) technologies, key information such as industrial operations, building materials, traffic density, parking lot data, roadways, outside storage areas, etc. were captured on a survey template and imported into GIS software. The predictive tool calculates broad range estimates of potential metal concentrations, identifies potential material sources, and predicts which drainage basins need

the most attention. All data are incorporated into a decision support tool that enables selection of appropriate best management practices and/or nonstructural source reduction measures to comply with NPDES permit requirements.

### More About the Tool


The function of the NPSSM tool is based on a multi-linear regression equation developed to model a pollutant (one was developed for copper and another for zinc). The equation includes explanatory variables that each represents a significant source of the pollutant as identified by statistical analysis such as building material, parking lot, and industrial activity. The statistical analysis involves taking all the potential sources of the pollutant

identified in the site characterization and narrowing down the possible sources to the most statistically relevant ones. In the equation, each coefficient represents the "weight" of the variable relative to each other. The tool also generates graphs of historical stormwater quality data along with management of stormwater quality data, records of inspections, and best management practices (BMP).

### Project Benefits

The NPSSM tool utilizes an existing GIS platform, and may be uploaded onto the Navy's GIS server for access at Navy sites around the world. The tool provides a means for simplifying BMP assessments required by Stormwater Pollution Prevention Plans, and it's easy to use, providing a visual analysis (graphical display) of metal pollutant "hotspots."

Application of this methodology is recommended as an iterative process where user input is practical for identifying, eliminating, and mitigating point sources of metals in stormwater runoff. The cost of a handheld GIS/GPS device for use during BMP assessments formatted with BMP checklist is approximately \$10,000. The device may also be available for rental.

The development and validation of the stormwater runoff methodology for identifying metals was made possible by the Navy Environmental Sustainability Development to Integration (NESDI) program. 

## The Basics About the NESDI Program

**THE NESDI PROGRAM** seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by NAVFAC EXWC in Port Hueneme, California. The program is the Navy's complement to the Department of Defense's Environmental Security Technology Certification Program which conducts demonstration and validation of technologies important to the tri-Services, EPA and the Department of Energy.

For more information, visit the NESDI program web site at [www.nesdi.navy.mil](http://www.nesdi.navy.mil) or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or [ken.kaempffe@navy.mil](mailto:ken.kaempffe@navy.mil).




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Vern Novstrup  
Naval Facilities Engineering and  
Expeditionary Warfare Center  
805-982-1276  
DSN: 551-1276  
[vern.novstrup@navy.mil](mailto:vern.novstrup@navy.mil)

## ASETSDefense Workshop 2016 to be Held December 6–8 in Orlando, FL



### Workshop Will Address Alternative Coatings & Surface Treatments

The Strategic Environmental Research & Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP), with support from the Office of the Assistant Secretary of Defense for Acquisition, Technology and Logistics (OASD-AT&L), are sponsoring the ASETSDefense 2016 Workshop—*Sustainable Surface Engineering Technologies for Aerospace and Defense*—to be held December 6–8, 2016 in Orlando, Florida.

ASETSDefense (Advanced Surface Engineering Technologies for a Sustainable Defense) is a SERDP and ESTCP initiative to provide engineering resources and information to the defense industry and a database for testing, qualification, and implementation. Approximately every two years, SERDP and ESTCP supports ASETSDefense workshops to provide an opportunity for design and sustainment engineers, industrial hygienists, and program managers to share recent developments and information on testing and implementing sustainable chemical and process alternatives. Workshops include presentations and posters, with an emphasis on discussion, including side meetings for the detailed examination of particularly significant issues and alternatives that are moving rapidly into production.

Engineers throughout the aerospace and defense industry are under constant and increasing pressure to improve the performance of materials, reduce corrosion and wear, and reduce the cost of acquisition and life-cycle sustainment. Simultaneously, occupational and environmental safety and health regulations are driving the replacement of the common surface treatments to combat wear and corrosion. European companies are under the strongest pressure because of Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulations, but U.S. companies and the Department of Defense (DoD) depots are under increasing U.S. Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA) pressure to eliminate cadmium (Cd) and hexavalent chromium (Cr + 6). (Note: The DoD REACH

Strategic Plan is available at [www.denix.osd.mil/cmrmp/chemicalmanagement/tsca/unassigned/reach-strategic-plan](http://www.denix.osd.mil/cmrmp/chemicalmanagement/tsca/unassigned/reach-strategic-plan).) Selling and maintaining U.S. weapon systems in Europe means that REACH also affects DoD and U.S. original equipment manufacturers (OEM); however, Cd and Cr + 6 can still be used in the U.S. with appropriate precautions.

The 6th Workshop on Sustainable Surface Engineering for Aerospace and Defense will be held at Shades of Green®, the Armed Forces Recreation Center at Walt Disney World® Resort, Orlando, Florida. Visit [www.ASETSDefense.org](http://www.ASETSDefense.org) for links to meeting registration and hotel information. The hotel room block is available from Saturday, December 3 to Saturday, December 10. Guest rooms within the block are secured at the Category 3/TDY rate for standard rooms. Reservations requested after the cut-off date (October 3) will be taken based on availability under the Group Name (ASETSDefense) and Code (1612USOD), at [www.shadesofgreen.org](http://www.shadesofgreen.org).

Occupational and environmental safety and health regulations are driving the replacement of the common surface treatments to combat wear and corrosion.

The replacement of Cd and Cr + 6 in manufacturing and depot maintenance will be featured. However, talks will cover all aspects of developing, testing, and implementing alternative coatings and surface treatments, with emphasis on the practical issues of performance testing, service evaluation, and approval and implementation of alternatives. As in previous ASETSDefense workshops, this meeting will include presentations from international partners—U.S., Canada, Britain, France, Germany, Australia, and New Zealand.

The following sessions are planned:

## Session 1: Aerospace and Defense Needs and Approaches

- Keynote: Scot Bryant (Noblis) describing results of a detailed evaluation of Cd and Cr + 6 replacement in Depots—impact, needs, and options
- Initiatives and funding projects in the U.S. and Europe

This meeting will include presentations from international partners—U.S., Canada, Britain, France, Germany, Australia, and New Zealand.

## Session 2: Hard Chrome and Other Wear Coatings

- Cold spray, nanophase cobalt-phosphorus, and trivalent hard chrome

## Session 3: Cadmium and Chromate Replacement at Depots and OEMs

- U.S. Air Force (USAF) Airworthiness Team and Naval Air Systems Command's (NAVAIR) hazardous materials reduction initiatives to develop, approve and implement alternatives
- Low hydrogen embrittlement zinc/nickel for Cd replacement—exploring in detail its use for landing gear, fasteners, electrical connectors and the F-35

## Session 4: Light Materials

- Approaches to improve repair while eliminating chromates, including talks by Airbus in Germany, Socomore and Safran in France, RUAG in Australia, Integran in Canada
- Implementing Tagnite for Army helicopters, and using cold spray to inhibit crack propagation in aluminum airframes

## Session 5: Localized Repair

- Non-drip brush plating, Tagnite and cold spray

## Session 6: Accelerated Corrosion Testing

- New USAF Advanced Environmental Severity Index

- Improvements over B117 (Standard Practice for Operating Salt Spray (Fog) Apparatus) testing

- Revitalization and modernization of MIL-STD-889 to incorporate computational corrosion modeling and prediction

## Session 7: Painting and Stripping Contamination Control

- Laser cleaning and depainting
- Dust minimization during paint sanding

## Session 8: Non-Chrome Paint Systems

- Non-chrome primer development and flight testing
- New NAVAIR aluminum-rich primers to inhibit corrosion and stress corrosion cracking
- Office of Naval Research Durable Aircraft and the Future Naval Capabilities Advanced Topcoat System
- Electrocoats, U.S. Army paints and primers, adhesive bond primers
- Phthalates—the next big issue

## Special Side Meetings

- Zinc-Nickel
- Cadmium-Chromium replacement in depots
- Gun barrel coatings
- Renewable materials for composites
- Networking and poster session


The entire agenda can be found at [www.asetsdefense.org](http://www.asetsdefense.org).

For more information about  
ASETSDefense 2016,  
visit [www.asetsdefense.org](http://www.asetsdefense.org).

ASETSDefense 2016 has been approved by OASD-AT&L to provide a venue for the exchange of information between DoD repair facilities, program managers, weapons system manufacturers and OEMs, research laboratories, and chemical and coating formulators concerning options, performance, and implementation of alternatives. An official approval letter from OASD-AT&L will be made available to DoD personnel upon request.



For more information about ASETSDefense 2016, visit [www.asetdefense.org](http://www.asetdefense.org).

SERDP provides a broad spectrum of basic/applied research and advanced development under an environmental science and technology program of DoD, and is executed in partnership with the Department of Energy, EPA, and other federal and non-federal organizations. ESTCP provides DoD with a demonstration and validation program for environmental technologies and promotes their transition from proof-of-concept to field or production use. For more information about SERDP and ESTCP, visit [www.serdp-estcp.org](http://www.serdp-estcp.org). 

Braxton Lewis  
Noblis  
703-610-2679  
Braxton.Lewis@noblis.org

**Tell Your Story in *Currents* • Deadline for our Spring 2017 issue is January 20, 2017**

Have some good news about your energy or environmental program? *Currents* is the place to tell your story. *Currents*, the Navy's official energy and environmental magazine, has won first place in the Navy's Chief of Information (CHINFO) Merit awards competition three times. Most recently, the magazine snagged an honorable mention in the last CHINFO competition. It's people like you and the stories you submit that make *Currents* the best magazine in the Navy.

**So if you have a story that you'd like to promote in our spring 2017 issue, submit your text and images by Friday, January 20, 2017. Any submissions received after this date will be considered for our summer 2017 issue.**

You can get a copy of the *Currents* article template by sending an email to Bruce McCaffrey, our Managing Editor, at [bruceMcCaffrey@sbcglobal.net](mailto:bruceMcCaffrey@sbcglobal.net). This template has proven to be a tremendous asset in helping us edit and track your article submissions. Bruce is also available at 773-376-6200 if you have any questions or would like to discuss your story ideas. And don't worry. If writing isn't one of your strengths, we'll handle all of the editing necessary to get your submission into publishable form.

As a reminder, your Public Affairs Officer must approve your article before we can consider it for inclusion in the magazine.

Don't forget to "like" us on Facebook at [www.facebook.com/navycurrents](http://www.facebook.com/navycurrents). *Currents'* Facebook page helps expand the reach of the magazine and spread the news about all the great work you're doing as the Navy's energy and environmental guardians.

## Currents Deadlines

Spring 2017 Issue: Friday, January 20, 2017  
Summer 2017 Issue: Friday, April 21, 2017  
Fall 2017 Issue: Friday, July 21, 2017  
Winter 2017-18: Friday, October 20, 2017

You can also refer to your 2016-18 *Currents* calendar for reminders about these deadlines.

## Chief of Naval Operations Recognizes Environmental Award Winners Via Virtual Ceremony

### Navy Saves Time & Money, Reduces Its Carbon Imprint

Chief of Naval Operations (CNO) Adm. John M. Richardson recognized the 29 winners of the fiscal year (FY) 2015 CNO Environmental Awards through a video teleconference (VTC) ceremony at the Pentagon on June 30, 2016.

The Navy selected winners in the ten categories of Natural Resources Conservation, Environmental Quality, Sustainability, Environmental Restoration, Cultural Resources Management, Environmental Excellence in Weapon System Acquisition and Afloat. This marks the fourth year the Navy has minimized its carbon footprint and travel costs by conducting the ceremony as a VTC. Awardees participating in the ceremony represented commands domestically and abroad.

Naval leadership and Department of Defense officials joined the CNO, along with Deborah Nagle, director of the water

permits division at the U.S. Environmental Protection Agency. Representatives of environmental organizations Sierra Club, World Wildlife Fund and Ocean Conservancy, which assisted in the judging process for the awards, also attended. A staffer from the congressional office of Rep. Ander Crenshaw (R-FL) participated, to acknowledge a command win in his district.

During the ceremony, Adm. Richardson spoke about the value of teamwork evident in the winners' efforts, and the value for lessons learned across the organization.

"The accomplishments of all of the winners should serve as opportunity...to educate everybody around us on those

best practices—what can be achieved—by successfully executing the mission and caring for the environment to the benefit of both."

Vice Adm. Philip H. Cullom, deputy CNO for Fleet Readiness and Logistics (N4) and Rear Adm. Doug Morton, then-director of the CNO Energy and Environmental Readiness Division (OPNAV N45), joined the CNO in congratulating the honorees and highlighting their accomplishments.

"I would like to extend my gratitude and sincerest congratulations to these well-deserved winners," said Cullom during the ceremony. "Your achievements embody the spirit of the Navy's responsibility to protect and defend our nation and, more broadly, Planet A—otherwise known as Earth—because there is no Planet B."



CNO Adm. John Richardson congratulating the winners of the FY15 CNO Environmental Awards.  
MC1(SW/AW) Nathan Laird

The CNO Environmental Awards program annually recognizes Navy installations, individuals, and teams for their significant achievements and contributions to environmental stewardship. More information can be found at <http://greenfleet.dodlive.mil/environment/awards/cno-environmental-awards>. [📌](#)

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Madeline Joyce  
Chief of Naval Operations Energy and  
Environmental Readiness Division  
703-695-5073  
DSN: 225-5073  
[madeline.joyce.ctr@navy.mil](mailto:madeline.joyce.ctr@navy.mil)

## Some Buzz About the “Honey Bee Program” Poster

**PERSONNEL FROM THE** Pacific Missile Range Facility (PMRF) and the U.S. Pacific Fleet’s environmental outreach program worked together to develop a poster for school students about the efforts at PMRF to protect honey bees. The poster highlights steps in the PMRF honey bee program and the importance of pollinators.

Honey bees contribute to the production of more than 90 crops and pollinate more than 250,000 species of flowering plants.

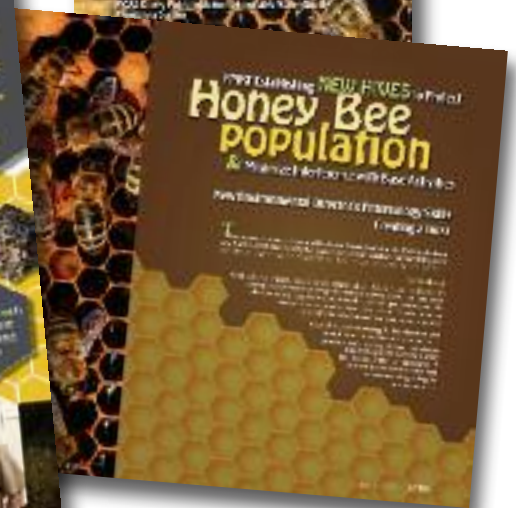
With a conducive climate and near-by agricultural lands, PMRF can have up to 15 bee swarms per year. Navy staff at PMRF recognized an opportunity and stepped in to help protect honey bees, Navy assets and facility occupants by establishing apiaries for relocating the swarms. Re-directing the bees into apiary hives allows PMRF’s

environmental staff to support honey bee populations by preventing them from being killed while providing additional protection by inspecting the bees for potential pests, monitoring hive health and sharing information with government agencies, researchers and beekeepers on Kauai.

The poster provides key facts about honey bees and illustrates key steps in the PMRF honey bee program. For example, honey bees contribute to the production of more than 90 crops and pollinate more than 250,000 species of flowering plants. It is one facet of PMRF’s effort to inform the public about honey bees and expand understanding of and support for honey bees and other pollinators.

For more details about the PMRF Honey Bee Program, see our article published in the summer 2016 issue of *Currents*—“PMRF Establishing New Hives to Protect Honey Bee Population and Minimize Interference with Base Activities.”

For an electronic copy of this poster, contact Lorraine Wass, our distribution manager, at [ljwass@outlook.com](mailto:ljwass@outlook.com) and 207-384-5249. 





# Honey Bee Program

Navy staff at the Pacific Missile Range Facility on Kauai protect honey bees and other pollinators.

## The Importance of Pollinators

Pollination is an important process for both agriculture and the environment. Much of the food we eat comes from crops pollinated by bees.

## Honey Bee Program

The process of protecting honey bees at PMRF:

Locate a bee swarm that could be harmful to people, aircraft, or buildings

Capture the swarm and relocate bees to apiaries (places where bees are kept)

Establish the hive



## Protecting Honey Bees at PMRF

Navy staff are working to protect honey bees by:

- Educating and informing the community of the importance of bees and pollination
- Monitoring bee populations
- Partnering with local beekeepers and the University of Hawaii and other organizations



## Did You Know?

### Honey bees:

- Produce honey, pollen, and beeswax
- Contribute to the production of more than 90 crops
- Pollinate more than 250,000 species of flowering plants
- Make more than 12 trips daily from the hive to thousands of flowers
- Contribute about \$15 billion every year to the value of agricultural crops
- Are in serious danger from poor nutrition, colony collapse, parasites, viruses, and pesticides

ge Facility (PMRF)  
ther pollinators.

e and the environment.  
by honey bees.

Inspect the  
hive for pests  
and parasites

Test the honey  
and beeswax  
for pesticides

Watch for any decline  
in the health of bees or  
the hive

Share  
information with  
government  
agencies and  
groups

For more information, contact John Nelson,  
PMRF Environmental Program Director, at  
808-335-4064 or john.d.nelson1@navy.mil

The best part  
of protecting bees  
at PMRF is harvesting  
tasty, local honey!

There are six hives  
currently at PMRF.  
Colony size is as  
small as 300 bees  
and as large as  
20,000 bees.

e health  
h the state  
groups



# Space Shot: Navy 3D Printed Part Delivered to International Space Station

## Part Designed by Three Truman Sailors

**THE DEPARTMENT OF** the Navy and members of the Congressional Maker Caucus made history on June 21, sending the digital file for a part designed by three Sailors aboard the aircraft carrier USS Harry S. Truman (CVN 75) to print on the International Space Station's (ISS) three-dimensional (3D) printer. This "virtual part delivery" marks the first time a Department of Defense-generated

part has been transmitted for printing in space, and the first time a Sailor-designed, 3D printed operational solution has been shared with outside government agencies via digital data transfer.

The part, called the Hydra Clip or "Tru-Clip," was designed by Aviation Electronics Technician Ashley Figert,



U.S. Navy Vice Adm. Philip Cullom, Deputy CNO for Fleet Readiness and Logistics, and members of Congress, press the button that will send a supply part file to be printed in space, during the Capitol Hill Maker Faire in Washington, D.C. The fair showcased robotics, drones, 3D printing and printed art.

*MCS2 Cyrus Roson*



U.S. Congressman Tim Ryan, U.S. Representative for Ohio's 13th congressional district, speaks during Capitol Hill Maker Faire in Washington, D.C.  
*MCS2 Cyrus Roson*

Chief Aviation Electronics Technician Jerrod Jenkins, and Lt. Casey Staidl in December 2016 and originally printed on a thermoplastic polymer 3D printer aboard the carrier. The Tru-Clip addresses a design issue with handheld radios, reinforcing the structure of radio antennas that tend to break while underway and saving the ship over \$42,000 in radio repair costs.

Following brief remarks by Vice Adm. Phil Cullom (Deputy Chief of Naval Operations (CNO) for Fleet Readiness and Logistics), congressmen Mark Takano (D-CA) and Tim Ryan (D-OH), the speakers jointly pressed a large red button labeled "Make in Space" which initiated the upload of the file. Congressman Paul Tonko (D-NY), Lt. General Michael Dana (Deputy Commandant, Installations and Logistics), Mr. Donald McCormack (Executive Director, Naval Surface and Undersea



U.S. Navy Lt. Gregory Dejute, 3D project officer for Mid-Atlantic Regional Maintenance Center, explains to a fair participant the benefits of a fabrication laboratory during the Capitol Hill Maker Faire in Washington, D.C.  
*MCS2 Cyrus Roson*



Aviation Electronics Technician 2nd Class Ashley Figert uses a 3D printer aboard aircraft carrier USS Harry S. Truman.  
*MCS3 B. Siens*



ABOVE: Capt. Ryan B. Scholl, Truman's commanding officer, left, presents Aviation Electronics Technician 2nd Class Ashley Figert with the Navy and Marine Corps Achievement award and medal during a ceremony aboard aircraft carrier USS Harry S. Truman.  
*MCS Seaman Jordan Twiss*



Chief Aviation Electronics Technician Jerrod Jenkins at work aboard aircraft carrier USS Harry S. Truman.  
*Kenneth Hess*



RIGHT: Capt. Ryan B. Scholl, Truman's commanding officer, left, presents Lt. Casey Staidl with the Navy and Marine Corps Achievement award and medal during a ceremony aboard aircraft carrier USS Harry S. Truman.  
*MCS Seaman Jordan Twiss*



U.S. Navy Vice Adm. Philip Cullom, Deputy CNO for Fleet Readiness and Logistics, speaks with Dr. Neil Gershenfeld, second from right, director of the Massachusetts Institute of Technology's Center for Bits and Atoms during the Capitol Hill Maker Faire in Washington, D.C.

*MCS2 Cyrus Roson*

This demonstration illustrates the power of the digital thread,  
and is the beginning of our future capability  
to manufacture mission-critical parts at the point of need.

*—Vice Admiral Phil Cullom*

Warfare Centers), and Andrew Rush, CEO of Made in Space, Inc., also participated. The file transfer was graphically depicted in real time on a flat screen monitor, which confirmed delivery to the ISS within approximately two minutes. The part printed successfully on the ISS printer later that evening.

“This demonstration illustrates the power of the digital thread, and is the beginning of our future capability to manufacture mission-critical parts at the point of need—whether ashore,

afloat, under the sea, or in space,” said Vice Adm. Cullom. “This is one small step for the Navy, and one giant leap for all of us.”

“[This effort] demonstrates deckplate innovation and the creative power of our Navy team. We can, and will, rewrite the supply chain,” Cullom concluded.

The event took place as part of the second annual Capitol Hill Maker Faire, a series of panel discussions and

exhibits that help inform Congress and the public about additive manufacturing (3D) concepts and technology developed by students, academia, government agencies, and the private sector, with the intent of bringing manufacturing back to America. 🚢

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Kenneth Hess  
Chief of Naval Operations Energy and  
Environmental Readiness Division  
703-695-5077  
DSN: 225-5077  
kenneth.hess@navy.mil



## ENERGY WARRIOR PROFILE

### DR. HEATHER WILLAUER

HOME STATE: Alabama



RESEARCH CHEMIST  
NAVAL RESEARCH LABORATORY (NRL)



*Did you know that carbon dioxide is 140 times more concentrated in seawater than it is in the air?"*

#### Q: WHAT ARE THE BASICS ABOUT CONVERTING SEAWATER TO JET FUEL?

Seawater to jet fuel is the process of taking seawater (capturing the CO<sub>2</sub> and H<sub>2</sub> from the seawater) and converting it into the components of jet fuel (designer fuel). The challenge is that this technology has never been developed—we are the first to do it. We're still doing basic research to understand the chemistry and how to best develop the technology.

#### Q: WHY DEVELOP THIS TECHNOLOGY?

The Navy is dependent on fuel. Everything that we utilize, every platform needs fuel. I would say that one of the biggest issues the Navy faces is getting the fuel to the location where the conflict is—often remote locations. Every three to five days, our ships have to stop working on the mission at hand, sail out to meet an oiler, transfer thousands of gallons of fuel, and then sail back to their operating areas. But what if you could make fuel when and where you needed it? If successfully developed, seawater to jet fuel has the potential to make a huge difference in our Sailors' lives. It will not only make their jobs easier and safer (refueling at sea is one of the Navy's more dangerous maneuvers), but will also allow them to focus on the mission at hand for longer periods of time. In the end, it will also help the Navy reduce its fuel dependency.



## ENERGY EFFICIENCY INCREASES

Dr. Heather Willauer (left) and her team, ENS Benjamin Poole and CDR Felice DiMascio.

The Electrolytic Cation Exchange Module (E-CEM) carbon capture skid.



### **Q: HOW DO YOU STAY MOTIVATED WHILE WORKING ON SUCH A CHALLENGING PROJECT?**

I have a great team. I am continually surrounded by good people. When one of us is down, the other one is up. The challenge ahead of us is really hard, but the science is also really exciting. We learn something new every day, realizing that this process, this technology, is actually possible. We are proving that it can be done and we're so excited about it. This research is not only good for the Navy, but for the world, too. And it's something we believe in.

### **Q: IF YOU COULD SHARE ANYTHING WITH THE DECKPLATE SAILORS, WHAT WOULD IT BE?**

Everything we do here at NRL is for our Sailors. They're the best! They put their families' lives on hold to go out there and serve us every single day. So we want to do something in return for them. We want our research to be effective, to make their jobs easier and safer. As scientists, we never know what they're going to encounter, what they're going to face so we want them to always be prepared. Having their perspective and knowing how to help them is something I highly value. I want them to know that we need their feedback. We want to know how best to help them. Many times we'll develop new technologies that break once out in the field—working in the laboratory sometimes creates a bit of a disconnect—we don't always have the best understanding of how our technology is really going to be used. So, feedback from the Sailors is critical to us. We want to get the product right.

### **Q: WHAT IS AN ENERGY WARRIOR?**

For me, being an Energy Warrior means being a good steward of the Earth—taking care of the planet we live on, using natural resources, and using what we have to give us energy. We have a significant amount of energy on this planet. The question is, how can we harness it cleanly and use it to our benefit? Instead of taking the easy way out and using fossil fuels, we need to go further and learn how to better harness that clean energy.

### **Q: WHAT IS YOUR FAVORITE SAYING?**

Well it's funny, because recently my husband came up with a mantra to live by: "Perspective is hard to gain, and difficult to maintain." Which means, sometimes we lose our sense of self, lose perspective on the important things in life. We often focus solely on the daily grind and lose sight of the big picture.

# NUWC Newport Leads Navy Research of Fuel Cell Technology

## Innovative Power Sources Sought to Extend Operating Range of AUVs

### AS NAVY REQUIREMENTS

expand in the undersea domain for autonomous systems with long endurance, Naval Undersea Warfare Center (NUWC) Newport is playing a key role in the development of air-independent propulsion systems.

Autonomous Undersea Vehicles (AUV) have the capability to venture where other platforms cannot, providing a standoff distance that allows the warfighter to operate in contested areas while remaining out of harm's way. The U.S. Navy uses AUVs for many diverse tasks, including intelligence, anti-submarine warfare, and mine countermeasures. Military AUVs are most effective when they can execute missions independently for extended periods of time ranging from tens to hundreds of hours, and as such, require high-energy, air-independent propulsion (AIP) sources. AIP refers to any underwater, non-nuclear

propulsion system that operates without the need for atmospheric oxygen.

Historically, the Navy has employed more traditional battery technology for its low-power AIP applications. However, the longer standoff distance necessary for AUVs to complete missions successfully requires a novel power source beyond current lithium battery technology. Fuel cells are a likely prospect, but those being developed by industry for consumer products are not addressing the unique needs of the submarine fleet because they typically rely on the consumption of air as an oxygen source. Investment in basic and applied research at Navy laboratories is required to address the unique challenges associated with the AIP environment.

The Office of Naval Research (ONR) regards NUWC Newport as the Navy's

underwater experts in the field of AIP for AUVs, and has tasked them with finding alternate methods of powering these unique vehicles.

Dr. Joseph Fontaine, head of NUWC Newport's Undersea Vehicles Propulsion and Energy Branch, leads a team of research engineers and scientists who are exploring safe long-endurance power sources for underwater systems.

"In general, the group works on air-independent energy sources for underneath the water line, from sensors requiring low power to torpedoes requiring considerably more power," says Fontaine. "For high-power systems, they use thermal combustion engines and power-dense batteries activated by seawater. AUVs are middle-of-the-road and fit into the spectrum for low-to-medium power levels, which are typically best suited for batteries and fuel cells."

AUVs have the capability to venture where other platforms cannot, providing a standoff distance that allows the warfighter to operate in contested areas while remaining out of harm's way.

Currently, AUVs rely on lithium ion batteries to meet their energy requirements; however, as witnessed in previous naval applications and consumer products, the risk associated with a lithium battery failure can be catastrophic. NUWC Newport is collaborating with the Naval Surface Warfare Center Carderock, Maryland and the Naval Surface Warfare Center Crane, Indiana—the Navy’s subject matter experts in lithium ion batteries—to provide a systems engineering solution for safely integrating this technology onto AUV platforms.

### The Promise of Fuel Cells

As AUV requirements continue to expand, fuel cells, which can potentially double the range of lithium ion-powered systems, are being considered as an energy source. Several types of fuel cells exist, but the Navy is currently focused on proton exchange membrane (PEM) fuel cells for AUVs.

A fuel cell converts chemically stored energy into electrical energy via a direct electrochemical reaction. This differs from a more traditional thermal based system (e.g., automotive engine, electrical power plant, etc.) where the fuel and oxygen are combusted to produce heat which is then converted to electricity via an energy converter (i.e., generator, etc.). PEM fuel cells use hydrogen as a fuel source, which is combined with an oxygen source (e.g., liquid oxygen, hydrogen peroxide, etc.). Besides the efficiency advantage of directly converting a fuel and oxidizer to electricity, water is the only byproduct of the reaction. Higher voltage is achieved by connecting multiple fuel cells in series to make a fuel cell stack,



Christian Schumacher holds the metal hydride alloys that may power AUVs.

*James Travassos*

similar to connecting batteries in series. Higher amperage is achieved by increasing the area of the fuel cell stack, similar to how batteries are connected in parallel. The result is a low-waste, high-efficiency, zero-emission source of propulsion with near-silent operation.

Previously, the Navy investigated the use of solid oxide fuel cells (SOFC) for AUV applications. The most significant difference between PEM fuel cells and SOFCs is their energy source and operating temperature. SOFCs can be powered by more than one kind of fuel, such as clean diesel, carbon monoxide, methane, hydrogen, and jet propellant, which notably is already onboard surface ships to power aircraft and helicopters. The use of higher-level hydrocarbons requires reforming to break them down to hydrogen and carbon monoxide for electrochemical conversion to water and carbon dioxide in the fuel cell. The operating tempera-

ture is typically in the 800 degrees Celsius range; however, SOFC-based systems for air-independent applications typically are more complex, incorporating several subsystems.

A more mature technology, PEM fuel cells provide greater than 50 percent efficiency, lower temperature operation, fast start-up, minimal balance of plant (components that are needed to operate the fuel cell such as blowers to circulate the hydrogen and oxygen, heat exchangers, and valves) and increased reliability (thousands of hours). The main challenge is the fuel source—very pure hydrogen, typically more than 99.999 percent hydrogen. The terrestrial method of employing a PEM fuel cell is to put it in a stationary place and bring in air from the outside. NUWC Newport’s efforts include the assessment and development of an additional oxygen storage/supply subsystem because they will be operating air independently. Each potential combination of

As AUV requirements continue to expand, fuel cells, which can potentially double the range of lithium ion-powered systems, are being considered as an energy source.

fuel/oxidant comes with a unique set of advantages and challenges—the balance between risk and reward is being refined to find the solution that meets both the technical requirements and the desired safety and logistical demands.

of compressed hydrogen along with the extremely low temperatures associated with cryogenic hydrogen (minus 423 degrees Fahrenheit) limit their suitability for AUV applications. This is further exacerbated by the challenges associated with safety,

says Schumacher, “So I started looking into metal and chemical hydrides for hydrogen storage.”

After conducting a literature review, he became interested in metal hydrides, which work like a sponge and enable hydrogen to be stored at lower pressure (less than 500 psi) and pose a much lower safety risk. Schumacher is investigating metal hydride alloys similar to those used in the German U212 submarine, which is powered by a Siemens PEM fuel cell system. These submarines use a hybrid diesel/PEM fuel cell, with the PEM fuel cell utilized while submerged.

“We are scaling this technology to a large-sized AUV,” says Schumacher. The commercially available hydrides need to be containerized properly for use on a Navy vessel. These hydrides provide good volumetric storage of hydrogen, but are too heavy for most applications since AUVs need to be neutrally buoyant. For smaller systems, Schumacher is researching chemical hydrogen storage systems such as aluminum hydride (AlH<sub>3</sub>), commonly known as Alane.



The NUWC Newport fuel cell team. Back row: Dr. Charles Patrissi, Dr. Craig Urian, Dr. John Izzo. Front row: Christian Schumacher, Dr. Joseph Fontaine, Jennifer Rizzo.

*James Travassos*

### Adapting Existing Technology

NUWC Newport research engineer Christian Schumacher is investigating emerging technologies to store hydrogen. Two options being investigated for commercial applications include high-pressure gaseous reactant storage and liquid hydrogen. However, the weight of the pressure vessel and general low storage density

shock, vibration, and implosion in an undersea environment.

“For PEM fuel cells, using compressed hydrogen for large AUVs does not provide energy levels that are significantly better than batteries on a systems level along with operational safety concerns associated with 10,000 and 15,000 pounds per square inch (psi) pressure vessels,”

### Safety & Testing

Schumacher’s goal is to develop a pragmatic, safe, Fleet-focused solution for fuel cell reactant storage and delivery that can pass the Navy’s “High Energy Systems Safety Manual” safety certification process. He has been instrumental in crafting the interim guidance for future safety testing and certification of future fuel cell systems.

Dr. John Izzo, a team member of the Propulsion and Energy group, conducts research and analysis of fuel cells, batteries, and additional energy systems, and serves as the test director for AIP at NUWC Newport. The group develops the test protocols, standard operating procedures, required safety packages (typically analysis for explosive atmospheres and oxygen safety), and data acquisition systems; and performs design /analysis to support the test and integration of the test item into the facility.

“Our role is to help develop fuel cell technology,” states Izzo. “There’s still work that has to be done to get fuel cells into the Fleet. There has to be enough of an improvement over lithium batteries to make fuel cells worth pursuing. They also have to be certified for safe operation and storage aboard a Navy platform.”

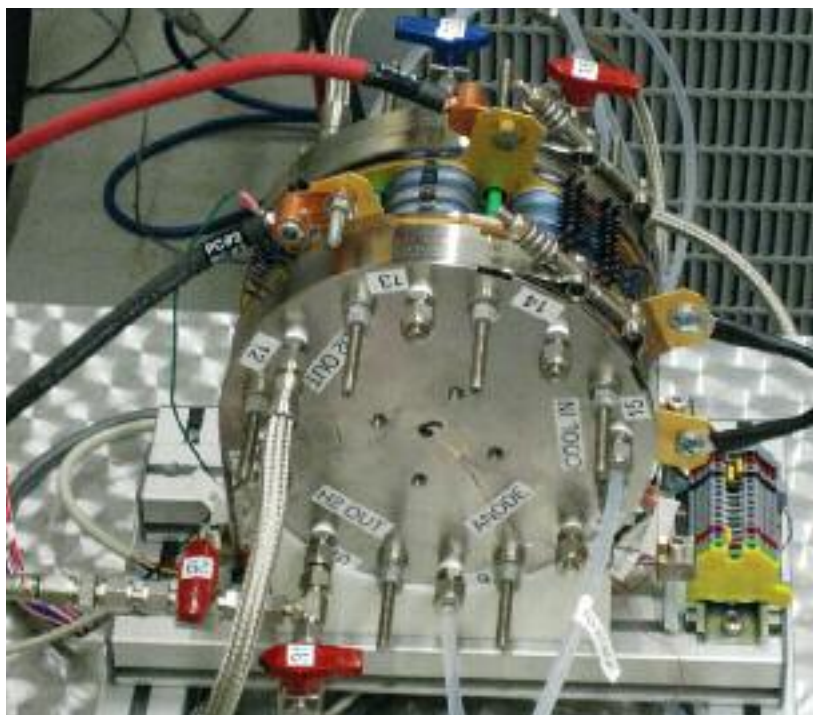
As NUWC Newport research engineers identify and investigate new technologies to power Navy vehicles, their role is not only to develop new concepts, but to analyze ideas and prototypes from their industry counterparts, as well as conduct trade studies in support of ONR, the Naval Sea Systems Command, the Defense Advanced Research Projects Agency, the Department of



Dr. John Izzo is NUWC Newport’s Test Director for AIP.  
*James Travasso*

## For More Details

**IN ADDITION TO** testing alternative energy systems, NUWC also serves as a model for energy conservation itself by utilizing a utility energy services contract with their local utility provider. For details, read “NUWC Newport Partners with National Grid to Tackle Energy Conservation: Annual Energy Savings of Plan Estimated at \$1.5 Million” in the summer 2014 issue of *Currents* at <http://greenfleet.dodlive.mil/currents-magazine>.



Small-scale prototype of a non-flow-through PEM fuel cell utilizing internal, responsive, product water management technology.  
*Christian Schumacher*



The Navy's undersea vehicles.  
NUWC Newport Graphics

Energy, the U.S. Army, and the National Aeronautics and Space Administration.

## More About NUWC

NUWC Newport's test facility was designed specifically to evaluate high-energy systems being developed for AUVs beyond lithium ion batteries. It is equipped to conduct fuel cell and thermal system testing, materials development and evaluation, battery design and prototyping, simulated undersea testing, prototype system integration, and reactor design and testing.

NUWC Newport is able to perform rigorous testing on each system and subsystem and provide the Navy with a comprehensive assessment of the technology. These systems typically involve a unique set of requirements that differ from test to test. The flexibility that has been designed in NUWC Newport's test facility is essential. The team lends their unique expertise and provides the technical oversight for determining which sources work best for different applications.

NUWC Newport has served as the Navy's principal test and evaluation laboratory for over a half a century in the area of test and evaluation of AIP energy systems for undersea vehicles from the component level to simulated operating ocean depths. Their test facilities include the Deep Depth Test Facility which is specifically designed to simulate deep ocean depths while conducting operational testing of torpedo propulsion systems and other battery-based systems. The test facility team at NUWC Newport specializes in test and evaluation of technologies ranging

from Otto fuel (monopropellant used to power torpedoes) to silver zinc batteries, flowing seawater-based aluminum silver oxide batteries, Stored Chemical Energy Propulsion System-based systems, and, most recently, the ability to test both PEM- and SOFC-based systems using oxygen sources ranging from air to 100 percent oxygen.

This knowledge base is currently being leveraged to the benefit of the next generation of more efficient and more energy-dense AIP solutions that could include fuel cell system technology, which will be constrained by many of the same operational issues of the legacy systems. In addition to SOFCs and PEM fuel cells, testing has included thermal engines, and system subcomponents such as power-dense direct-current motors and reactant delivery systems. Their research, which is tested under unique and extreme conditions, has contributed to the advancement of fuel cell technology.

The fuel cell stacks and other energy sources are examined with the expectations of the Fleet in mind. Different tech-



Christian Schumacher briefs NUWC Newport personnel on the latest fuel cell research.

David Stoehr

## ONR's Future Naval Capabilities Program

**INITIATED BY THE** Department of the Navy in 2002, the FNC program is a science and technology program designed to develop and transition cutting-edge technology products to acquisition managers within a three- to five-year time-frame. Through the FNC program, ONR proposes technology investments called enabling capabilities to address science and technology gaps.

The program has nine functional areas:

### 1. Capable Manpower

Intuitive systems and personnel tools for matching Sailors and Marines to the right jobs and training for mission-essential competencies.

### 2. Enterprise and Platform Enablers

Cross-cutting technologies to lower acquisition, operations, and maintenance costs.

### 3. Expeditionary Maneuver Warfare

Naval ground forces with special emphasis on regular and irregular warfare.

### 4. Force Health Protection

Medical equipment, supplies and procedures to reduce morbidity and mortality when casualties occur.

### 5. FORCEnet

C4ISR, networking, navigation, decision support and space technologies that provide an architectural framework for naval warfare in the information age.

### 6. Power and Energy

Energy security, efficient power and energy systems, high energy, pulse power.

### 7. Sea Basing

Logistics, shipping and at-sea transfer technologies that provide operational independence.

### 8. Sea Shield

Missile defense, antisubmarine warfare, mine warfare and fleet/force protection technologies that provide global defensive assurance.

### 9. Sea Strike

Weapons, aircraft and expeditionary warfare technologies that provide precise and persistent offensive power.

nologies and subcomponents are compared, and the team determines how well the fuel cell stacks work, as well as how safe and useful they might be on Navy platforms. As these technologies progress, NUWC Newport is writing the rules for implementation into naval platforms, with the safety of the warfighter being their highest priority.


"Safety is a big focus," says Izzo. "It has to be safe. We can't put the platform at risk. There is some level of risk that is accepted but it has to be tempered. There's a long list of safety requirements for high-energy systems."

NUWC Newport's work addresses "Power and Energy," one of the pillars of ONR's Future Naval Capabilities (FNC). Their research also touches on ONR's Innovative Naval Prototypes, which are defined as "high-payoff, high-risk, game-changing, emerging technologies that define the Navy's future battlespace." PEM fuel cells can potentially power large-sized AUVs by providing new AIP systems and core vehicle technologies to extend endurance to months of operation time.

"Other groups are working with hydrogen storage technologies," states Fontaine. "Because of our experience in the energetics field, fuel cell development and underwater

systems engineering, we're able to guide the emerging technology through the safety certification process."

For NUWC Newport, the overarching goal is to power AUVs for long periods of time so they can conduct longer missions without stopping for re-charge.

"The NUWC Newport team is conducting critical research, testing, and evaluation to advance fuel cell technology and improve the mission endurance of AUVs," said Rear Admiral Moises DelToro III, Commander, NUWC Newport. "Their work will allow AUVs to operate for extended periods of time as a force multiplier and keep our warfighters out of harm's way. This technology has the potential to benefit the Fleet immensely." 

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Joseph Fontaine  
Naval Undersea Warfare Center Division Newport  
401-832-2887  
DSN: 432-2887  
joseph.fontaine@navy.mil

John Woodhouse  
Naval Undersea Warfare Center Division Newport  
401-832-4256  
DSN: 432-4256  
john.woodhouse@navy.mil

# Building Competitions Save Energy in the Pacific Northwest

## Advanced Meters Provide Feedback on Energy Behavior

**BUILDING ENERGY USE** competitions are yielding results at Navy commands in the Pacific Northwest. Competitions bring more awareness to energy use on base and engage building occupants to get involved.

In the Pacific Northwest, the concept of an energy use competition started at Naval Air Station (NAS) Whidbey Island in Washington State and has spread to Naval Base Kitsap. Chris Taylor, the installation energy

\$500,000 (10.5 percent) that year, largely due to matching heating loads to actual building occupancy.

Seeing the potential to use energy data to further engage building occupants and reduce energy cost, Taylor began the beta testing phase of a Tenant Energy Efficiency Program in 2014 with a few select representative organizations. He wanted to verify assumptions about scoring and program goals.

improve operation and maintenance of energy-using systems.

Prompted by the success at NAS Whidbey Island, Tabitha Pierzchala, the installation energy manager at Naval Base Kitsap Bangor, held a competition at Naval Base Kitsap. The initial competition included 11 buildings and five tenant commands. Buildings were selected to maximize leadership awareness by selecting buildings occupied by senior leaders.

The first full year of quarterly competitions resulted in a net savings of more than \$121,000 in electricity cost.

manager at NAS Whidbey Island, began to study advanced meter data in 2013 and began to notice trends. New meters that can report energy use by time of day for individual buildings were installed in 2012 and began to collect data. Taylor identified high energy use at several buildings and evaluated their use patterns. He reached out to building occupants and challenged the hours of occupancy that they claimed. His efforts reduced energy cost by more than

The first full year of quarterly competitions (fiscal year 2015) led to engagement with 29 commands in 20 facilities and resulted in a net savings of more than \$121,000 in electricity cost. This constituted a 4.3 percent reduction from the previous year for participating facilities. The competitions at NAS Whidbey Island involved the same buildings each quarter, and have resulted in more focus energy savings as facility managers actively look for ways to

The competition concluded with modest results. In the three months of the competition the net savings reached 2.6 percent.

Encouraged by the positive results, Pierzchala and Naval Base Kitsap Bremerton energy manager Paul Songe-Moller organized a second competition. The competition involved 21 buildings at Puget Sound Naval Shipyard and Intermediate Maintenance Facility which uses

45 percent of the energy for the entire region. The competition organization and awareness campaign ran from January through March, and the competition ran in April 2016. The competition focused on using weekly reports of advance meter data as feedback and prompting engagement from building managers. This competition resulted in a net savings of 162 megawatt-hours of electricity and \$16,000 savings in electricity cost for April 2016—a very respectable 9 percent electricity reduction for the 21 buildings involved. Because Naval Base Kitsap Bremerton has approximately 10 million square feet of facilities, and the effort required to evaluate and present the meter data, competitions are currently rotating among small groups of tenants and facilities. This keeps the meter data reviews and interaction with competitors manageable.

At both commands, energy competitions foster a culture of energy efficiency and challenge building occupants to pay attention to their energy consumption. Leadership is taking notice. As they review accomplishments and present awards, their support for the program is reinforced.



Capt. Mike Nortier, NAS Whidbey Island Commanding Officer presents James Reynolds, Fleet and Family Readiness Center (FFRC) building manager with a \$10,000 Facility Improvements Big Check for energy saved by the center. Wayne Short, FFRC director, is holding the trophy and Cmdr. Steve Richards is at the podium.

Marcie West

### For More Information

**FOR MORE INSIGHTS** into NAS Whidbey Island's efforts to match heating and cooling loads to actual building occupancy, read our article "Matching Building Energy Use to Requirements and Occupancy: NAS Whidbey Island Ensures Energy Use Correlates with Energy Demands" in the spring 2015 issue of *Currents* at <http://greenfleet.dodlive.mil/currents-magazine>.



## Energy competitions foster a culture of energy efficiency and challenge building occupants to pay attention to their energy consumption.

Tips for conducting a successful energy competition include:

- Get command level buy-in from the start.
- Decide which buildings to include in the competition. Double check the consumption during the baseline period to make sure each building in the competition has a good baseline for comparison. An installation-wide competition can run using the Facility Energy Management report in the Navy's Comprehensive Utilities Information Tracking System (CIRCUITS) for consumption data. Competitions that target small groups of buildings, like a tenant command, can be executed using the Usage and Variance report or a trending report from the Meter Data Management module in CIRCUITS to track consumption data.
- Advertise the competition using methods such as e-mail, social media, command newsletters and posters. Start planning three months before competition kickoff, so the level of effort doesn't interfere with existing workloads. Start the awareness campaign four to six weeks before the kickoff.
- Make personal visits to the building manager for each tenant command or building in the competition. Consider which devices receive no use after hours then, take a walk through to see how many remain on during this time. Ask competitors to identify ways to save energy in their facility.
- Provide regular feedback to each building manager on their energy consumption. Consider providing feedback in the form of a utility bill or send an energy use graph for the previous week. Ask building managers to forward or post the feedback and results to date in their buildings.
- Score the competition based on a combination of best energy practices by the building manager and actual energy reduction during the competition period.
- Reinforce the concept that saving energy saves money which can better fund the mission.
- Have an award ceremony with the commanding officer. Provide awards such as a traveling trophy or plaque, an energy flag, or individual awards from the command's existing employee recognition program. Consider designating resources from the building maintenance budget for a facility improvement award for the winner, and present it as a large check signed by the commanding officer. Publicize best practices done by facility managers. ⚓

### For More Insights

**FOR INSIGHTS INTO** another approach at an energy competition, read our article "NAS Sigonella Named Energy Biggest Loser in Navy Region EURAFSWA Competition: Second Annual Competition Pits Bases in Energy Reduction Battle" in the winter 2015-16 issue of *Currents*. The Energy Biggest Loser competition, hosted by Navy Region Europe, Africa, Southwest Asia, challenges installations in the region to reduce their own energy consumption.



Leslie Yuenger  
Naval Facilities Engineering Command  
Northwest  
360-396-6387  
DSN: 744-6387  
leslie.yuenger@navy.mil

# **Currents 2016–2018 Calendar Celebrates Navy Efforts to Conserve Energy & the Environment**

## **Two-Year Calendar Highlights Award Winners**

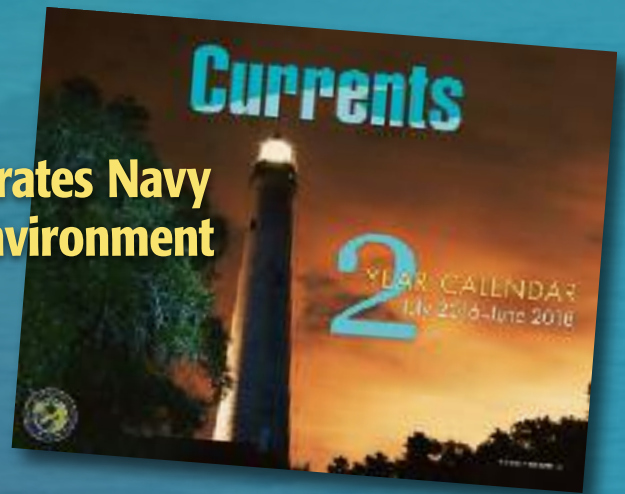
Our latest *Currents* magazine's calendar covers two full years and is full of the great work by winners of Secretary of the Navy (SECNAV) Environmental and Energy and Water Management awards. It also shares some Earth Day history and Navy Earth Day activities.

Your calendar, which began with July 2016, carries you all the way through June 2018. The calendar presents a different award category each month, alternating between the Environmental and Energy and Water award programs.

We kick off 2017 with the Natural Resources (Large Installation) award. The prompt and cooperative action by Joint Base Pearl Harbor-Hickam, Hawaii to contain an invasive species—the Coconut Rhinoceros Beetle—garnered the Navy's award. For the Marine Corps, Marine Air Ground Task Force Training Command at Twentynine Palms, California is giving the threatened desert tortoise with a "head-start" in life. The Tortoise Research and Captive Rearing Site protects the vulnerable soft-shelled juveniles from predators and gathers information to help bolster the species.

Among new additions to the SECNAV Energy & Water Management award program are two aviation categories—the Commander, Naval Air Force Pacific Aviation Squadron and Commander, Naval Air Force Atlantic Aviation Squadron awards. May 2017 highlights the winning efforts by Strike Fighter Squadron One Three One (VFA-131) that captured the Atlantic award. The Pacific winner, Strike Fighter Squadron Fourteen (VFA-14), is profiled in October 2017 (Energy Action Month). The squadrons were recognized for innovative approaches to minimizing fuel consumption.




A third new category in the Energy & Water Management arena is the Military Sealift Command Category. See the May 2018 for a summary of how USNS Matthew Parry (T-AKE 9) took the honors there.



As the Navy's official energy and environmental magazine, *Currents* has the privilege to share the many ways the Navy's energy and environmental personnel and Sailors work to find and implement the best techniques to achieve their goals. *Currents* provides a forum in which all of you can share your knowledge and successes with your colleagues.

If you subscribe to *Currents* magazine you should have received your 2016-2018 calendar by now. If not, please contact Lorraine Wass, our distribution manager, at [ljwass@outlook.com](mailto:ljwass@outlook.com) to receive your own copy. You can also find the calendar and issues of the magazine online at <http://greenfleet.dodlive.mil/currents-magazine>.

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Thanks for all of your great work and we look forward to seeing more from you in the pages of *Currents* magazine and in our next calendar!



# SSC Pacific Scientists Perform Studies to Support a New Apra Harbor Discharge Permit

## Efforts Include Mixing Zone Analysis, Recalculation Procedure & Other EPA Methods

**A MULTI-YEAR COOPERATIVE** effort between personnel from the Naval Facilities Engineering Command (NAVFAC) Marianas and the Space and Naval Warfare Systems Center Pacific (SSC Pacific) has placed U.S. Naval Base Guam's Apra Harbor Wastewater Treatment Plant (WWTP) on a clear path to compliance.

In 2005, the Navy's Apra Harbor WWTP was placed on the U.S. Environmental Protection Agency's (EPA) Significant Non-compliance (SNC) list for violations of its National Pollution Discharge Elimination System (NPDES) permit. This SNC designation indicates a serious level of violation as noted in EPA databases.

In June 2010, NAVFAC Marianas entered into a Federal Facilities Compliance Agreement (FFCA) with EPA for the plant as part of a proactive approach to achieve NPDES compliance. Concurrently, NAVFAC Marianas engaged the environmental sciences division at SSC Pacific to request technical assistance in achieving compliance.

In consultation with NAVFAC Marianas, SSC Pacific developed a technical approach to meet the requirements of the FFCA in a timely, technically sound and cost-effective manner. The scientific approach considered the outdated and

unachievable discharge limits set by the 2001 Guam Water Quality Standards and pertinent EPA guidance documents to develop site-specific permit limits.

### Assessing Compliance

Before any work began, the SSC Pacific team and NAVFAC Marianas discussed their methodology with EPA and Guam EPA. Considering the long-standing SNC violations and other historical factors, getting the regulators to "buy in" to the scientific principles at work was challenging. It took strategic and cooperative team efforts consisting of multiple face-to-face meetings, presentations and negotia-



Aerial view of Tipalao Bay.  
Google Earth ©2016

tions with the regulators to gain their willingness to consider SSC Pacific's scientific approach. These collaborative efforts proved to be an important first step, and were vital in streamlining the regulatory process and incorporating the study results into the final permit.

Adhering to EPA guidance throughout the project, the SSC Pacific team had three overarching goals:

1. Validate a mixing zone.
2. Develop site-specific criteria for copper, nickel and aluminum.
3. Verify clean chemistry procedures so that sampling numbers are accurate and precise.

According to EPA's Technical Support Document "USEPA-505-2-90-001," a triad of approaches should be used to assess water body health: whole

effluent, chemical-specific, and biological assessments. In other words, what specifically is in the effluent (outfall), how does it affect living organisms, and how well does it mix into adjacent receiving waters?

### The Mixing Zone Analysis

In multiple situations, EPA and State regulations allow for the use of a mixing zone to determine points of



The diffuser at the end of the outfall pipe.



The meter in position, 90 feet from the outfall pipe.

No one had ever looked at it and said, “Wait a minute, this isn’t appropriate.”

—Pat Earley

regulatory compliance within a waterbody at a set distance away from the end of a discharge pipe. A mixing zone is described by the EPA as “a limited area or volume of water where initial dilution of a discharge takes place and where numeric water quality criteria can be exceeded.” It is important to note that EPA has never approved a mixing zone for Guam. Upon approval, this will be the first such approval.

To make this determination, a model was needed. The team chose the Cornell mixing zone model known as CORMIX. This EPA-accepted model was used to simulate the discharge environment and evaluate the behavior of the plume from the industrial submarine outfall into Tipalao Bay, Guam.

The CORMIX modeling framework uses existing data on the physical characteristics of the discharge, flow volume and contaminant characteristics of the effluents, ambient hydrodynamic conditions and contaminant levels, and other discharge characteristics to simulate theoretical steady-state discharges from the wastewater treatment plant. This allows for estimates of the size of the mixing zone that would be needed to meet water quality standards under a wide range of environmental conditions. To supply the data needed

for the modeling tool, the team deployed an Acoustic Doppler Current Profiler (ADCP) to take three-dimensional measurements through the water column and capture the direction and velocity of the different ambient currents.

“In any given location, currents don’t all flow in the same direction or at the same speed,” said Pat Earley, SSC Pacific’s environmental science branch head. “The top may be flowing north to south. Twenty feet lower it could be flowing due west.”

The meter was positioned 90 feet from the end of the discharge pipe. This distance was based on a decision to be

close enough to characterize the currents that would affect the outfall, but far enough away so that it wouldn’t be influenced by the outfall itself.

With the data provided by the ADCP and other parameters, the CORMIX tool validated the mixing zone conditions at the specified distance. The range of modeling parameters was run through multiple scenarios. Selection of the most environmentally conservative combination of these parameters, (e.g., no current and high discharge rate) predicted a minimum dilution factor of 29.7 at the edge of the mixing zone. “This value is applied to the permit limits,” said Earley.



The Tiger Shrimp (*Penaeus monodon*) is one of the new species added to the database for Guam.

Courtesy of Wikipedia Commons



The Lace coral (*Pocillopora damicornis*) is one of the new species added to the database for Guam.

Ahmed Abdul Rahman

“It’s a divisor that demonstrates you are protective of the environment and meeting water quality criteria within the mixing zone given the worst possible combination of environmental and discharge conditions.”

Discussing real world scenarios, Earley added, “If we took the average dry weather conditions, which are usually occurring at this outfall, and the tenth percentile ambient current, which is still conservative, water quality standards are met within 20 feet from the outfall diffuser.” (Note: The diffuser is an attachment on the end of the outfall pipe, where the effluent gets into the surrounding water.) Utilizing the most conservative parameters, the team calculated the hypothetical amounts of copper, and nickel that would have to be discharged to exceed the water quality criteria: copper at 115 micrograms per liter; nickel at 566 micro-

grams per liter. These concentrations are higher than have ever been measured associated with the Apra Harbor Discharge.

### Removing Aluminum

“We started investigating the water quality criteria for aluminum and realized that it was essentially an error,” stated Earley. Back in 1988, the wastewater treatment plant’s NPDES permit was assigned a 200 microgram per liter limit for aluminum discharge. However, that figure was based on fresh water standards. EPA has never established saltwater water quality standards for aluminum. “They incorporated these criteria into the Guam Water Quality Standards a long time ago,” said Earley. “No one had ever looked at it and said, ‘Wait a minute, this isn’t appropriate.’ Once we showed it to the regulators, they agreed to reconsider this criteria in

the next permit and in the Guam Water Quality Criteria.”

This finding may have implications for Florida Navy facilities as well because Florida’s standard for aluminum discharge is also based on the outdated freshwater standard.

### Site Specific Criteria

Each water quality standard is set based on a national database that includes hundreds of tests on organisms, organized by genus and species, some of which may not be present in Guam. In order to customize the permit to the discharge environment, the team chose to follow an EPA-approved mathematical method known as the recalculation procedure. While state EPA offices are not obligated to recognize this scientifically defensible approach, Guam EPA was completely open to



Dr. Ignacio Rivera and Gunther Rosen, members of the SSC Pacific project team, perform standard toxicity tests on the Long Spined Urchin.

its use. “The recalculation procedure allows you to make permit limits site specific,” Earley said.

The procedure is a step-wise method that involves corrections, additions, and deletions to the national toxicity data set, rendering it more representative of species occurring at a specific site.

The first step in the process was to make corrections to existing datasets. In some cases, the SSC Pacific team found mathematical errors in EPA datasets. In other cases, outdated science was being cited. For example, the Water Quality Criteria (WQC) being cited in the plant’s existing permit was based on 1995 standards. However, in 2012 a revision was proposed which incorporates a large number of corrections and a much larger dataset (over three times the number of species).

Earley explained how WQC limits are calculated. “For each data set, a dose/response curve is plotted and some conservative calculations are applied to derive a water quality criterion that provides for protection of 95 percent of the aquatic community 95 percent of the time.”

The team conducted an extensive review of species present in the Marianas region. It was discovered that the most sensitive species under the old criteria was the Blue Mussel. Earley’s team was able to remove this species because it does not exist in the waters around Guam. Similarly, some species were added that were unique to Guam—species that were not in the national database. In fact, so many new species were added to the dataset that it expanded from a total of 26 to 67 individual organisms. Conventional wisdom might expect the limits to go down in this case, but after running the calculations the limit levels for copper and nickel actually increased.

“It’s not easy to actually revise numbers upward,” Earley said. “You have to bring a lot of science to the table to show them that we’re not being less environmentally protective.”

When recalculating the numbers for nickel, the team went out and collected samples of a local genus to supplement the data. “We didn’t have any data for the local Long Spined Urchin,” Earley said. “So in coopera-

tion with the University of Guam, we went out and collected this local organism and performed standard toxicity tests on it,” he said. “Following the rules in the EPA guidance document, we replaced the Long Spined Sea Urchin that was in the database with another variety, *Diadema antillarum*.” Results were published in a scientific peer-reviewed publication *Bulletin of Environmental Contamination and Toxicology* (Volume 95, Number 1, pages 6 to 11, 2015). This addition renders the criteria more appropriate for Guam in particular, and the Marianas region overall.

The new copper limits proposed by the team are 4.9 micrograms per liter for acute (at the end of the pipe) and 9.9 micrograms per liter for chronic exposure. These figures are based on total recoverable levels of the metal, which is the measure EPA generally uses to determine toxicity of a water body. There are two ways to measure metals. Earley explained, “The total recoverable form includes metal bound-up to particulates that don’t cause toxicity to organisms (they are not bioavailable). The dissolved form is what enters into

cell walls and kills the organisms.” EPA recognizes that the dissolved fraction of metals better represents the bioavailable portion of the metal in natural waters, so following EPA guidance, the team converted total recoverable metal levels to dissolved metals to more accurately describe potential environmental toxicity. In the case of copper, it was determined that 57 percent of the metal was bioavailable—the rest was bound and essentially harmless to aquatic life. In the case of nickel, it was 77 percent bioavailable.

“We try to attain early agreement with the regulators and make the case that we’ll apply the science and whatever the numbers are, we should all accept them. We’re not trying to simply get our permit levels raised. The Navy is willing to go through the extra costs and efforts to follow

would have to increase by 10 times more than the highest ever reported values in order to impact water quality beyond the established mixing zone. The findings are supported by an absence of significant toxicity in any of the laboratory tests with the most sensitive species in EPA’s species sensitivity distribution.

The current draft permit contains provisions that allow for a mixing zone, new discharge limits for copper and nickel as well as the removal of aluminum from the permit requirements. This successful effort has resulted in a scientifically defensible NPDES permit that is achievable and has removed the Apra Harbor Wastewater Plant from EPA’s SNC list. “Getting early regulatory concurrence on our approach was crucial,” concluded Earley.

## This successful effort has resulted in a scientifically defensible NPDES permit that is achievable and has removed the Apra Harbor Wastewater Plant from EPA’s SNC list.

EPA guidance and develop site-specific criteria that are protective of the environment. We just follow the science and accept the numbers.”

### Sampling Techniques

In order for samples to be reliable, clean sampling techniques are essential. Clean sampling refers to all the parameters that might affect water sample quality, from ensuring that laboratory conditions are pristine to controlling conditions during sample collecting. According to Earley, “It takes a tiny particle to contaminate a sample and make it look like you have a much higher concentration.”


After discussing proper techniques, SSC Pacific and Guam performed sample splitting, where each laboratory would run identical water samples. “We split samples with them and were able to inform their techniques and processes so that their data gained precision and reliability,” Earley reported.

### The Bottom Line

The results of this study suggest that the near-shore areas around the island of Guam are not impaired for copper or nickel. Effluent concentrations at the end of the pipe

### Looking Ahead

All of the work performed by the team to evaluate copper and nickel toxicity has larger implications than the outfall from the wastewater treatment plant in Guam—it’s applicable to the entire Marianas region, and will be incorporated into the triennial review of Guam Water Quality Standards, a required process by which states or territories collaboratively review and update water quality standards.

Additionally, the team’s methods, including consideration of dissolved versus total recoverable levels of metals, site-specific additions and deletions to the species database, and clean sampling techniques, are applicable to NPDES permit holders throughout the Navy. Coupled with the availability of the Biotic Ligand Model, currently under review, Navy facilities will be armed with new scientifically defensible tools to streamline permit negotiations, be protective of the environment, and meet environmental compliance requirements. 

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Patrick Earley  
Space and Naval Warfare Systems Center Pacific  
619-553-2768  
DSN: 553-2768  
earl@spawar.navy.mil



# POWER. PRESENCE.

## ENERGY ACTION MONTH 2016 REINFORCES NAVY'S ENERGY RESILIENCY

Through a presidential proclamation, October has been designated as Energy Action Month to stress the importance of energy for our nation's economic vitality today and for a sustainable future.

The Navy's Energy Action Month theme for 2016, "Power. Presence." illustrates the strong connection between the Navy's wise use of energy and its ability to be when and where it is needed for national security and humanitarian assistance missions worldwide.

In honor of Energy Action Month, naval commands are demonstrating their commitment to energy resiliency by reducing energy consumption and promoting awareness of energy as an enabler of combat capability. Highlights of the Navy's recent energy progress include the following:

- **Integrating shore-based renewable energy sources and optimizing fuel use**  
This integration and optimization led to a 15 percent decrease in Navy petroleum demand from fiscal year 2008 to fiscal year 2014.
- **Leveraging culture change to achieve energy goals**  
Through increased training and implementation of best practices with existing equipment, as much as 58 percent of the Navy's projected fuel savings by 2020 is expected to result from shifts in workforce behavior.

- **Deploying the Great Green Fleet (GGF)**

To support one of the Secretary of the Navy's key energy goals, the USS John C. Stennis (CVN 74) Strike Group deployed in January 2016 from San Diego as part of the GGF. This initiative showcases energy efficient technologies, alternative energy uses and best practices. Similar energy efforts by other ships and shore installations, as well as Marine Corps assets, are ongoing worldwide throughout the year.

- **Scheduling the installation of hybrid electric drives (HED)**

HED installations are planned on select Arleigh Burke class destroyers in 2016. The HED allows ships to use an electric motor powered by the ships' generators for propulsion at low speeds (under 12 knots) and use the ship's main gas turbine engines at higher speeds where they are most efficient. The HED is projected to decrease fuel consumption by up to 16 percent, translating to an extra 2.5 days between refuelings.

- **Installing light-emitting diode (LED) lighting on Navy ships**

LED lights save approximately 1.8 megawatts of energy annually (or the equivalent of one million gallons of marine diesel fuel).

- **Surpassing renewable energy goals**

The Navy exceeded its goal of one gigawatt of renewable energy for naval bases worldwide, with over 1.1 gigawatts in procurement by the close of 2015. (Note: One gigawatt equates to the power of roughly 250,000 homes.)

- **Facilitating the development of solar facilities**

Solar facilities help to power Navy bases around the globe. Through the Navy's Renewable Energy Program Office, thirteen solar projects have been fully executed to date, saving \$90 million in nominal energy costs.

- **Showcasing Sailors and civilians involved in energy projects**

Via the Energy Warrior app and other methods, the Navy is highlighting its personnel who are engaged in energy-saving projects and/or have ideas that can inform and inspire the Navy workforce. Through the Energy Warrior digital platform, the Navy recognizes innovative people and encourages commands to submit energy ideas—during the month of October and beyond.

Energy Action Month is an opportunity to engage with friends and colleagues on approaches for utilizing energy more strategically in day-to-day jobs and in support of the mission.

Learn more about Energy Action Month at [greenfleet.dodlive.mil/energy/energy-action-month-2016](http://greenfleet.dodlive.mil/energy/energy-action-month-2016).

Download the Energy Warrior App



# Energy Action Month 2016

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Look for Energy Warrior in the App Store

# Naval Hospital Bremerton Pharmacy Implements New Innovations

## Efforts Include Program to Safely Handle Discarded Medications

**NAVAL HOSPITAL BREMERTON'S** (NHB) pharmacy has recently implemented two innovative programs to safely handle discarded medications and help dispense pre-ordered prescriptions.

NHB is piloting a patient medication takeback program. A 'MedSafe' medication disposal container is now located in the outpatient pharmacy lobby and is available during normal hours of operation.

According to Sharon Marker, NHB Pharmacy Inventory Manager, anyone who has medication that they don't want or need can bring them in to dispose of properly.

"We did this so anyone who has been holding expired medications or drugs they no longer need will have a safe, convenient, and responsible means of disposing of them," said Marker.

Acceptable medications for disposal include pills, tablets, capsules, ointments, creams, lotions, and powders. Liquid medicines no more than four ounces may also be disposed of, but must be in their original containers, wrapped in a paper towel and sealed in a plastic bag before being placed in MedSafe.

"We do accept Schedule II-V substances now like Percocet, so patients no longer need to go to the Kitsap County Sheriff's office. Also, our providers can now instruct patients to dispose of their medication in the bin if they feel they should no longer be on it. That said, our staff will not take medications from patients and dispose of it for them," said Lt. Zachery Hearn, NHB Pharmacy Officer.

"We don't accept sharps, including auto-injectors like epinephrine, fluids over four ounces, or aerosols including albuterol inhalers. These things must be disposed of by the patients," continued Hearn. (Note: Sharps are defined as needles, syringes, scalpels, lancets, and intravenous tubing with needles attached.)

MedSafe is not for illicit drugs specifically Schedule 1 controlled substances—drugs or another substance with a high potential for abuse—such as marijuana, cocaine, heroin, and methamphetamine.

The program is also not for chemotherapy waste or other medical waste in receptacles. Other items not taken include batteries, aerosol spray cans, trash or hazardous materials, alcohol or hydrogen peroxide, mercury thermometers, or chemicals.

We did this so anyone who has been holding expired medications or drugs they no longer need will have a safe, convenient, and responsible means of disposing of them.

—Sharon Marker

“This is a great program—proof that the Navy is serious about protection of the environment,” said Ramon Calantas, NHB Environment Technician, citing a U.S. Geological Survey report that found contaminants from pharmaceuticals have been detected in water and soil worldwide.

“Chemicals in medications enter the environment through secretion and disposal of unused pharmaceuticals in sewers, septic tanks, and landfills. Treatment plants are not equipped to remove the pharmaceutical compounds before releasing them into local waters. Disposal of pharmaceuticals into landfills only postpones the pollution of groundwater—eventually they will leach into the groundwater. Proper disposal of unused and unwanted pharmaceuticals will reduce the amount of pharmaceutical compounds flowing into our waterways. Collection and incineration is the best alternative to reduce the flow of pharmaceuticals into the environment,” concluded Calantas.

Along with the new MedSafe disposal option, NHB employees with Department of Defense prescription benefits can access the command’s internal web-based SharePoint site to submit refill requests. This is an additional option to the telephone refill line and TRICARE online.

The service is for NHB employees that have pharmacy benefits and Composite Health Care System (CHCS) prescriptions. The service processes refills or new prescriptions already entered by the provider into CHCS to be picked up at NHB’s outpatient pharmacy.

Lt. Cmdr. Eric Parsons, NHB Pharmacy Department head, confirms that the idea for this service was discussed during leadership rounds, where it was discovered a similar capability was already in place at Naval Hospital Camp Lejeune.

“We contacted the folks at Naval Hospital Camp Lejeune and then set about to make it happen here. Will Seward took it on to develop the program while the pharmacy validated its functionality and determined that it was robust enough to implement at NHB. Peggy Hall from NHB’s Information Management Department was a huge help. This service directly benefits staff, as well as their



Medication disposal is now available at NHB, accepting consumer unused or expired prescribed controlled and non-controlled medications, such as over-the-counter dispensed medications. Accepted for disposal are pills, tablets, capsules, ointments, creams, lotions, powders, and liquid medicines no more than four ounces.

families, by eliminating a step and saving time,” said Parsons. (Note: To use this service, prescriptions—whether refills or new prescriptions—must already be in the system.)

“There still might be times that the pharmacy will have to contact the staff member to discuss the medication request. We could have questions on the therapeutics of the order, such as ensuring the person is aware of potential side effects,” added Parsons.

These two innovative programs at NHB’s pharmacy continue to improve convenience and experience to better serve Sailors, Marines and their families—one unneeded prescription drop-off and one needed medication pickup at a time. [↱](#)

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Douglas Stutz  
Naval Hospital Bremerton  
360-475-4665  
DSN: 494-4665  
[douglas.stutz@med.navy.mil](mailto:douglas.stutz@med.navy.mil)

# NPS Investigates Renewable Powered Heating Ventilation & Cooling with Thermal Storage

## ESTEP Project Seeks to Lower Facility Operating Costs & Increase Energy Security

**WITH RESOURCES PROVIDED** by the Energy Systems Technology and Evaluation Program (ESTEP), researchers at the Naval Postgraduate School (NPS) have investigated and installed a thermal energy system to provide supplemental power for facility heating and cooling systems.

### Background

Using renewable energy reduces the Navy's dependence on fossil fuels and traditional sources of electricity. Renewable energy is often fed into the commercial energy grid to offset costs. But if the grid fails, access to these renew-

able resources is lost. Additionally, while current state laws often stipulate that a utility must sell electricity from renewable sources at cost, this situation is unlikely to continue. Rather, it is likely that renewable resources will start to be treated like more traditional sources of energy—meaning that power plants sell energy at a certain price to the utility and the utility resells it at a higher price to consumers. With these factors in mind, using renewable energy 'behind the meter' is a better way of reducing costs.

From an energy security standpoint, being energy self-sufficient when the grid fails is essential for U.S. Navy facilities. At present, a fuel farm and some form of backup generation is used for this purpose.

NPS and other researchers are investigating ways to enhance the performance and longevity of microgrids, battery storage and backup generators to allow for longer periods of off-grid operation. Allowing access to renewable resources when the grid fails could extend the length of time that a generator's fuel farm can last.

NPS and other researchers are investigating ways to enhance the performance and longevity of microgrids, battery storage and backup generators to allow for longer periods of off-grid operation.

able resources is lost. Additionally, while current state laws often stipulate that a utility must sell electricity from renewable sources at cost, this situation is unlikely to continue. Rather, it is likely that renewable resources will start to be treated like more traditional sources of energy—meaning that power plants sell energy at a certain price to the utility and the utility resells it at a higher price to consumers. With these factors in mind, using renewable energy 'behind the meter' is a better way of reducing costs.

Using backup generators and batteries to allow for off-grid operation assumes that the best methods for storing and transporting energy utilize hydrocarbons and electricity. But at the NPS in Monterey, California, researchers Anthony Gannon and Anthony Pollman are questioning this basic assumption. Through their ESTEP project, they have created an energy storage system designed specifically for heating and cooling needs.

In a paper written about the project for an American Society of Mechanical Engineers conference, Gannon and

Pollman state, “To effectively start to tackle the problem of energy generation, storage and transport, the end application of the energy should be used as the starting point in designing systems and making best use of the vast array of new technologies becoming available.”

The end application that often uses the most energy at a Navy facility is heating, cooling and ventilation, which incorporates building heating and cooling, hot water heating, and data center cooling. In order to better store energy for these systems, the researchers designed and constructed a thermal energy storage system at the NPS Turbopropulsion Laboratory.

Thermal energy refers to the energy stored in a substance due to its temperature. This form of energy storage is safer, more economical, and has a longer lifecycle than battery storage systems.

### Hot Thermal Storage

In times of excess generation or cheap electricity being available, this energy can be stored, often in a water tank. Another common way of storing energy thermally is with the use of ceramic bricks—the approach chosen by NPS researchers. These bricks are heated using an electrical element and stored in a specially designed unit that allows them to maintain heat for up to three



In the front of this unit are the thermal bricks used to store heat. This small free-standing unit, suitable for a single room, was used to develop control strategies and test the program being used before moving onto the control of a larger unit.



The large installed thermal storage unit weighs approximately 2,100 pounds, and can store 120 kilowatt hours (kWh) or 426,500 British Thermal Units of heat. It has one moving part (the fan) which blows air through the unit and is therefore very simple to operate and maintain.



The ice storage tank used in the system has a 144 kWh of thermal storage capacity. The mixture pumped through the tank is 75 percent water and 25 percent propylene glycol. Propylene was chosen over ethylene glycol as it is suitable for food grade applications and is not harmful to humans if accidentally ingested in moderate amounts. Propylene has a slightly higher viscosity, but this slight loss in system efficiency becomes less of an issue when a renewable power source is used.



The complete cooling system includes a variable speed chiller and pump. This system will be used to cool a large compressor's exhaust air before it enters a storage tank. Control signals can be sent to the chiller for it to operate between 20 to 100 percent of its rated capacity. The fluid pump can run separately from the chiller to circulate the chilled mixture through whatever device requires cooling.

days. When a space must be heated, air is blown through the bricks and exhausted into the space. The heating elements are controlled by solid state silicone controlled rectifiers which can be instantly programmed to adjust the amount of power being sent to the heating elements.

This technology can also be used in parallel with a normal forced air heating system and has the advantage of being less complicated than using a tank filled with liquid.

### Cold Thermal Storage

In the case of cooling, there are a number of commercially available systems that make use of the heat of formation that is required to freeze and melt ice. A cold solution of water and antifreeze is circulated through tubes immersed in a tank that contains water. Water then freezes and accumulates on the outside of the tubes. When cooling is required, hot water from a cooling system can be deposited into a thermal storage tank, which then melts the ice and cools the solution for recirculation through the system.

### Integrating the System

While both the cooling and heating systems installed for this project are based on commercially available components, the ability to effectively integrate these components into a renewably powered system required some modifications.

It was also imperative that the devices be controllable locally so that the demand from the systems could be closely matched with the available renewable supply. The development of this control system was quite challenging.



The microgrid used for this ESTEP project. It is essential that communication and data be extracted from such systems to obtain the most value from them.

The main issue involved with creating this control system was obtaining data from the renewable resources on how much power is available.

### Challenges

Because the communication and control standards vary greatly among industries, the project team created and implemented a control algorithm to send commands out to the system.

The main issue involved with creating this control system was obtaining data from the renewable resources on how much power is available. To accomplish this task, the team connected the local microgrid to a control computer to gather available incoming power data, after which the heating or cooling system power was adjusted accordingly.

At the outset, the researchers assumed that the main challenge would be the development of the control system. However, just as challenging was communicating with manufacturers regarding the concept of matching demand to available supply. Microgrid systems are

designed on an assumed usage of a certain number of Joules or kilowatt hours per day. Researchers discovered resistance to developing a system where electrical demand is matched to the available supply and energy stored in other forms.

The varying communication and control standards among industries made it challenging to integrate components and ensure that products from different industries were compatible. Therefore custom components had to be ordered for both the heating and chilling systems.

### Conclusions

The construction of these demonstration systems has proven invaluable—most importantly because it has proven that systems designed with the end use in mind are possible.

## The Basics About the Energy Systems Technology and Evaluation Program

ESTEP FOCUSES ON energy technologies that reduce costs, increase energy security, and ultimately increase the reach and persistence of the warfighter. ESTEP seeks to identify viable emerging energy technologies, obtained for the most part from open-market sources and in-house government demonstrations. Technologies identified as promising by ESTEP will be demonstrated, and data will be collected to evaluate the performance and reliability of selected technologies under various environmental and operating conditions. The entire program encompasses the following investment areas:

- Cyber and Energy Management for Information Systems
- Power and Energy Components
- Power and Energy Production/Efficiency

Established in fiscal year 2013, ESTEP casts a wide net across the Department of the Navy, academia, and private industry to investigate and test emerging energy technologies at Navy and Marine Corps installations. At present, ESTEP conducts nearly two dozen in-house government energy projects, ranging from energy management to alternative energy and storage technologies. Additionally, an ESTEP Broad Agency Announcement has awarded several contracts to industry in those same energy areas.

In addition to testing and evaluating performance and reliability of energy technologies, ESTEP provides mentoring (via on-the-job training and education of interns) and other workforce development opportunities by partnering with the Troops-to-Engineers program for veterans at San Diego State University and other universities. Workforce and professional development are key components of ESTEP and integral to the success of executing and transitioning energy technology projects at naval facilities.

ONR provides funding and oversight for ESTEP, and program management is being handled by the Space and Naval Warfare Systems Center Pacific. The Naval Facilities Engineering and Expeditionary Warfare Center and the NPS are executing selected research projects, and every project plans to involve at least one veteran intern utilizing an ESTEP grant to academic institutions.

For more information about ESTEP, contact Stacey Curtis at 619-553-5255 and [stacey.curtis@navy.mil](mailto:stacey.curtis@navy.mil).



Ultimately, this system could serve as a model for forward operating bases and remote stations. The thermal storage makes the system grid-independent, and helps to extend battery life. In addition, commercial equipment can be readily purchased, transferred to, and set up in international areas.

While the construction of this system will reduce the cost of energy at NPS, these facilities are also available for other U.S. Navy and Department of Defense personnel to inspect and possibly adapt for their own purposes. These facilities have also provided enormous educational opportunities for NPS postgraduate students as they advance their field of knowledge.

### For More Information

Three dissertations have been completed by students working on this project. These documents are available on the NPS Thesis and Dissertation Collection website:

1. "Initial investigation of a novel thermal storage concept as part of a renewable energy system," by L.M. Olsen at <http://hdl.handle.net/10945/34716>.
2. "Hot thermal storage in a variable power, renewable energy system," by T.D. Hinke at <http://hdl.handle.net/10945/42645>.
3. "Control strategy: wind energy powered variable chiller with thermal ice storage," by R.A. Boonyobhas at <http://hdl.handle.net/10945/44525>. [📎](#)

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Anthony Gannon  
Naval Postgraduate School  
831-917-1032  
[ajgannon@nps.edu](mailto:ajgannon@nps.edu)

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CNO Energy and Environmental Readiness Division (Code N45)  
2000 Navy Pentagon, Room 2E258  
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